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THE BOARD OF CONSULTING ENGINEERS OF THE ISTHMIAN CANAL COMMISSION.

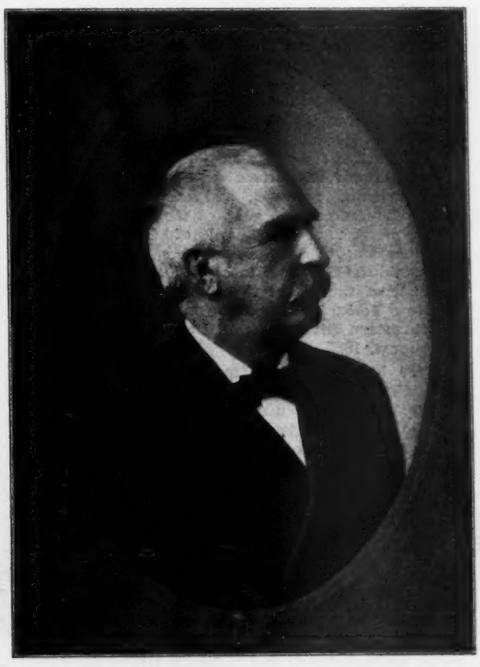
On Sept. 1 there met at Washington a group of eminent foreign and American engineers appointed by President Roosevelt as a Board of Consulting Engineers to the reorganized Isthmian Canal Commission. In his order of June 24, 1905, President Roosevelt named nine American and four foreign engineers as members of the board and stated that a fifth foreigner would be named at a later date. The nine Americans, one of whom was unable to serve, were named first and in the following order: Gen. Geo. W. Davis, Messrs. Alfred Noble, Wm. Barclay Parsons, Wm. H. Burr, Gen. Henry L. Abbot, Francis P. Stearns, Joseph Ripley, Isham Randolph and Herman Schussler. The foreign members, as nominated by their respective governments, were: Wm. Henry Hunter, England; Eugen Tincauzer, Germany; Adolphe Guerard, France. In addition, Edouard M. Quellennec was selected as being Consulting Engineer of the Suez Canal, and the nominee of the Netherlands remained to be announced. After having been selected from the last-named country and on the eve of his departure for America, Prof. J. Kraus, of the Technical College of Delft, was elevated to the cabinet of his country. In his place Johan W. Welcker was named. Mr. Schussler being unable to serve, there was nominated as the ninth American engineer Mr. J. B. Berry, Chief Engineer of the Union Pacific R. R., but owing to his declination the board met as 13 instead of 14 engineers.

President Roosevelt designated General Davis as Chairman of the Board of Consulting Engineers and he stated the duties of the Board substantially as follows: To consider "the various plans proposed to and by the Isthmian Canal Commission for construction of a canal across the Isthmus of Panama, between Cristobal and La Boca." The order expressly stated that the board might continue its deliberations as long as it deemed "necessary and wise" and that if thought necessary the Board might visit the Isthmus before submitting its final report. In case of disagreement, minority reports are to be made.

It may be a convenience to some to have it stated that the present Isthmian Canal Commission, as constituted by an order issued April 3, 1905, is as follows: Theo. P. Shonts, Chairman; Chas. E. Magoon, Governor Canal Zone; John F. Wallace, Chief Engineer (since resigned); Rear Admiral Mordecai T. Endicott, U. S. N.; Brigadier General Peter C. Hains, U. S. A.; Col. Oswald H. Ernst, Corps of Engineers, U. S. A., and Benj. M. Harrod. Of these seven men only Mr. Harrod was on the original commission, appointed in 1904, but several members of that Commission are on the Board of Consulting Engineers, as stated in connection with the biographies given below. The new Chief Engineer of the Commission is Mr. John F. Stevens, but he is not a member of the Commission.

The Board of Consulting Engineers will report to the Commission on the best plan for the Canal and particularly on the question of locks versus sea level, and the Commission will then make its own report and conclusions (to the President). Should a change to a sea-level plan be advised the decision would have to be approved by Congress, since the existing law provides only funds sufficient for the estimated cost of a lock canal. Further details regarding the reconstituted Commission, with brief sketches of the members, may be found in our issue of April 6, 1905.

Through the kindness of the several members of the Consulting Board of Engineers we are enabled to present herewith their portraits and brief biographical sketches.



Geo. W. Davis

GEORGE W. DAVIS.

General George W. Davis, the Chairman of the Board of Consulting Engineers of the Isthmian Canal Commission, was born in Thompson, Conn., July 26, 1839. The son of a farmer, his education was secured principally at the public school in his native village and in an academy in an adjoining town.

He volunteered for the Civil War in 1861 and has been in the military service continually since, save for a few months at the close of the Civil War. He has filled every military grade from that of Sergeant of Volunteers, which position he held at the outbreak of the Civil War, to Major General of the regular army, and has held many important assignments, his last being the command of the entire military forces of the United States in the Philippines.

The scope of General Davis' duties often included civil engineering, architecture and building construction. During the Civil War, while serving with the army in Virginia, he was charged with the construction of extensive barracks, wharves and storehouses. At various times from 1867 to 1878 he was in charge of the construction of permanent barracks, depots, etc.

In 1878, he became the Assistant Engineer in the work then assumed by the Government of the completion of the national monument to Washington, in the District of Columbia. He was actively and continuously employed on this difficult and then unprecedented undertaking, which included the reconstruction, extension and strengthening of the original foundations of that massive, though incomplete, structure, so that stability might be secured for supporting the weight of the most lofty masonry structure in the world. This work was completed in 1885—without serious injury being incurred by any person employed upon it.

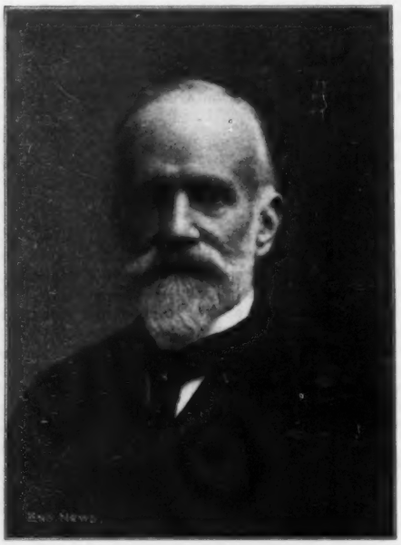
In 1889, General Davis was placed in charge of the Department of Engineering in the Army Staff College at Fort Leavenworth. In pursuance with the special authorization of Congress in 1890 he was granted leave and appointed General Manager of the Nicaragua Canal enterprise, the construction of which work had been undertaken a year or two before by a private corporation. For three years he held this position. The inability of the company to finance the undertaking brought all operations to a close in 1893.

In 1899 General Davis was appointed Governor of Porto Rico and in this capacity he directed the operation of the engineers engaged in the construction of roads and bridges. Upon these objects about $1,000,000 was spent during his administration.

In 1901, while commanding in the Philippines, he directed the explorations and opening of extensive unknown regions and also the construction of an extensive system of roads and bridges

throughout those wilds. While holding the chief military command in the Philippines in 1902-03 General Davis directed the extensive road, wharf and barrack construction then in progress in those islands.

In March, 1904, he was appointed a member of the Isthmian Canal Commission and soon after was designated the managing representative of all operations in progress on the Isthmus of Panama. He had charge of all engineering work until the arrival of the chief engineer in July, and thereafter remained, until a few weeks ago, as Governor of the Canal Zone. He constantly



visited the centers of greatest activity and studied on the spot for a year the conditions that must be encountered in making the Canal.

HENRY L. ABBOT.

General Abbot's first field service was as assistant on the explorations for the Pacific Railroad in California and Oregon up to May 19, 1857; and then on the hydrographic survey to protect the alluvial region of the Mississippi against overflow, to July 1, 1861.

When the Civil War broke out he was appointed Chief Topographical Engineer of General Daniel Tyler's Division in the Manassas campaign of July, 1861, being engaged in the action of Blackburn's Ford and in the battle of Bull Run, where he was wounded. He was employed in constructing field works south of the Potomac until the Peninsular campaign of 1862, in which he took part as aide-de-camp to General Barnard, the Chief Engineer of the Army of the Potomac, being engaged in the siege of Yorktown, and the operations before Richmond, and the preparation of the official maps of the campaign until July 24, when he was disabled by the Chickahominy fever. Rejoining General Barnard in September he was engaged in fortifying the southern approaches to Alexandria until appointed Chief Topographical Engineer of the Banks Expedition to the Gulf of Mexico in November. Being appointed Colonel of the First Connecticut Artillery on Jan. 19, 1863, he returned and commanded the regiment and a brigade in the defences of Washington to May 10, 1864, also serving as a member of the board to reorganize our system of sea coast fortifications, and organizing a siege train for the contemplated movement against Richmond. Proceeding with his regiment to Bermuda Hundred, he commanded the siege artillery of the Army of the James from May 13, to June 23, 1864, and then the siege artillery of the armies operating against Richmond to the end of the war, except when detached with a siege train as Chief of Artillery of the Terry Expedition against Fort Fisher. After serving as Chief of Artillery of the Department of Virginia from May 10 to July 13, 1865, and commanding a brigade in the defences of Washington until Sept. 25, 1865, he was mustered out of the volunteer service with his regiment, on that date. He had received five brevets in the Regular Army and two in the Volunteers, the highest being that of Major General.

General Abbot's first service after the war was as assistant to General Humphreys in an examination of the condition of the Mississippi levees. He was then assigned to the command of the engineer battalion and the construction of Fort Schuyler (N. Y.), on June 1, 1866, and to the command of the post and construction of the fortifications at Willet's Point (N. Y.), on June 12, 1868. Here he remained until May 24, 1886, engaged chiefly in inaugurating the Engineering School of Application and in experimentally establishing a system of submarine defence for the seacoast of the United States. Other important duties were the following: Member of the Board of Engineers to conduct experiments in the use of iron in permanent defences, 1866-67; under the Secretary of the Treasury to observe the solar eclipse of December, 1870, at the Island of Sicily; in 1873, to proceed to Europe to make contracts for torpedo cable, and to observe systems of submarine defence adopted by Great Britain, Germany, Austria and France; in 1868-69, a member of the Board to reorganize the Pontoon Equipage for the United States Army; in 1869-79, a member and executive officer of the Board of Engineers for Fortifications in matters relating to torpedo defence; in 1874-75, a member of the Board of Commissioners to devise a permanent plan for reclaiming the Alluvial Basin of the Mississippi; in 1877, member of the Board to examine the Contracts between the United States and the Moline Water Power Co.; from September, 1879, to August 13, 1895, a member, and after July, 1888, the President of the Board of Engineers for Fortifications and River and Harbor Improvements. But few projects for important harbors on the sea and gulf coasts of the United States failed to receive official action from this Board.

In 1883-84, he was a member of the joint Army and Navy Gun Foundry Board, which determined the adoption of the existing system for the manufacture of heavy ordinance; in 1885-88, a member of the Endicott Board to examine and report at what ports, fortifications or other defences are most urgently required, and the character and kind of defences best adapted for each; in 1888-95, a member of the Board of Ordnance and Fortification; in 1886-95, member of the Board to establish Harbor Lines in Boston; 1888-95, member of the Board to establish Harbor Lines at New York; he was Division Engineer of the Northeastern Division, from December, 1888, until August, 1895.

After his retirement from active service, in 1895, General Abbot was the consulting engineer of the Wisconsin Central R. R., to prepare plans for the interior harbor of Manitowoc; was President of the Board of Consulting Engineers on the Ship Canal projected from Pittsburg to Lake Erie, by the Chamber of Commerce of Pittsburg; was Chairman of the Jury of Higher Awards at the Atlanta Exposition of 1895; was member of the Forestry Commission appointed by the President of the National Academy of Sciences on application of the Secretary of the Interior, 1896-97; from April, 1897 to July, 1900, he was a member of the International Comité Technique of the New Panama Canal Co., and in 1898, a member of its Commission Statutaire, remaining its Consulting Engineer until the transfer of its properties to the United States in April, 1904.

General Abbot is a member of the National Academy of Sciences, of the American Philosophical Society, of the American Academy of Arts and Sciences, of the National Geographic Society, and a corresponding member of the Imperial Royal Geological Society of the Austrian Empire. He inherits membership in the Society of the Cincinnati. The degree of LL.D. was conferred upon him by Harvard University in 1886.

Besides being the author of many professional and biographical papers, General Abbot has just finished compiling a book on the Panama Canal, which will be of the greatest value to the New Commission. It is a concise account of the information obtained by the several Canal Commissions of which he has been a member, much of it being translated from the French Reports. The title of this work is: "Problems of the Panama Canal, including Climatology of the Isthmus, Physics and Hydraulics of the Lower Chagres, Cut at the Continental Divide, and Discussion of Plans for the Waterway." It was published by the Macmillan Co. of London and New York, in April, 1905.

WILLIAM HUBERT BURR.

William Hubert Burr was born at Waterbury, Conn., on July 14, 1851. After studies at the Watertown Academy and in private he was admitted to the Rensselaer Polytechnic Institute from which he graduated in 1872 with the degree of C. E. For the next three years he was engaged on wrought iron bridge construction and on the water-works of Newark, N. J.

While continuing to practice as a civil engineer Mr. Burr, in 1875, became a member of the faculty of the Rensselaer Polytechnic Institute, serving as professor of mechanics from 1876 to 1884.

Dropping for a time his professorial work he became assistant to the chief engineer of the Phoenix Bridge Co. in 1884, and later was made general manager of that company. In 1891 he served as vice-president of the engineering firm of Sooysmith & Co., while in 1892-3 he was professor of engineering at Harvard University.

The latter position was left to assume a similar one at Columbia University, which he has retained until the present time.

President Cleveland chose Professor Burr, in 1894, as a member of the board of engineers to investigate a one-span bridge across the Hudson River at New York City, and in 1896 appointed him on a board to locate a deep water harbor on the coast of South Carolina. In 1899, President McKinley appointed Professor Burr a member of the first Isthmian Canal Commission and in 1904 President Roosevelt selected him for a like position on the Isthmian Canal Commission appointed to construct the canal.

Reverting to 1894, Mr. Burr in that year served on a committee on rapid transit in New York City. During 1895-8 he was a member of the Board of Consulting Engineers to the New York Dock Department, and since then has served in a similar capacity for various New York City departments and commissions, including the Chairmanship of the Commission on Additional Water Supply, appointed in 1903, and the position of consulting engineer to the Bridge Department.

Professor Burr is now a member of the Board of Trustees of the Cathedral of St. John the Divine, under whose direction the great cathedral is now rising on Morningside Heights, New York City. He is also a member of the American Society of Civil Engineers, of the Institution of Civil Engineers of Great Britain, and of the National Geographic Society. Besides lesser contributions to engineering literature he is the author of

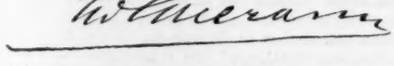
"The Stresses in Bridges and Roof Trusses" (1881); "The Elasticity and Resistance of Materials" (1883); and "Ancient and Modern Engineering and the Isthmian Canal" (1902).

ADOLPHE GUERARD.

Adolphe Guerard, one of the French representatives on the Consulting Board, was born in Vosages, at Raon-l'Etape, France, on July 3, 1841. He entered the Ecole Polytechnique and graduated therefrom with the second highest rank in his class. Upon his graduation he chose the Ponts et Chaussées branch of the army in preference to the other arms of the service on account of his marked tastes for constructive engineering. Upon leaving the Ecole des Ponts et Chaussées he was sent to the World's Exposition of 1867 at Paris. Here he was attached to the staff of Alphand, the Director of the Promenades and Parks of Paris, who was in charge of the construction of the Park of the Exposition. For more than two years Guerard had charge of the design and construction of this Park, under Alphand.

After these beginnings, M. Guerard was called to direct, in February, 1868, the important maritime works under construction at the mouth of the Rhone for the building of the maritime canal and the port of St. Louis. In spite of the isolation of the locality and the unhealthfulness of that climate, where fevers held sway during a part of each year with such violence that work had to be discontinued for three months, M. Guerard established his residence in the center of the works, in order that he should be better able both to conduct operations and to exercise that constant direction and surveillance that was necessary. These very remarkable and difficult works demanded his presence on the spot for more than six years.

In 1873, the Cross of the Legion of Honor was bestowed upon the young engineer "for having," as the decree of Oct. 18, 1873, reads, "conducted to a successful termination, and with talent, the works of the canal of St. Louis, in the midst of difficulties of every nature."



After the completion of the canal of St. Louis, M. Guerard was attached to the maritime service of the Department of the Deltas of the Rhone, with residence at Marseilles, where the extensive works of that port and harbor called him. After he had perfected the docks of this naval station, constructed the National dock, and the outer harbor of Marseilles, M. Guerard was occupied, in connection with the Chamber of Commerce, in equipping the port with machinery. It is to him that is due the installation of sheds and depots, of hydraulic machinery, and of iron rails for the quay, in the furnishing of which the Chamber of Commerce most actively concurred, and which has been most instrumental in making the port of Marseilles one of the best equipped with machinery in the world. M. Guerard was the author of the project for the dock recently built to the north of the National dock, and was one of the prime movers in the project for the construction of the great navigation canal which is to join the port of Marseilles to the Lake of Berre and the River Rhone, the work on which, declared to be of public utility by an Act of the Assembly of Dec. 24, 1903, will be immediately prosecuted.

Credit is due M. Guerard for his close studies upon the deltas of the Rhone and upon the utilization of the Lake of Berre as a harbor of refuge, as an industrial harbor in connection with the harbor of Marseilles and as a military port, and upon the administration and management of the ports of commerce and the proportions to be given to the different parts of the ports.

M. Guerard's work on the epidemic of cholera which visited Marseilles in 1884 and 1885 won for him a prize from the Medical Department of the Institute of the Academy of Sciences at its meeting in 1886.

M. Guerard has been charged with numerous missions abroad: in Asiatic Turkey, in Syria, Egypt, Tunis, Portugal, Holland, England, Russia, Roumania, and Bulgaria; and in South America upon the Rio de la Plata and de la Parana. He is the author of a number of projects for foreign ports upon the Mediterranean and Baltic seas and upon the Atlantic Ocean, and particularly for the ports of Tunis, Bourgas, Varna, Constantinople, Lisbon, Montevideo and Santa Fe; at all of which harbors the works are being prosecuted or are already completed.

In 1892 M. Guerard was appointed by the French Government as a member of the International Commission which was charged with the study of the questions of improving the sanitary conditions so as to render healthful the city of Cairo, and it was upon the completion of the task of that commission which also comprised an English and a German engineer, that the French Minister in Egypt wrote to the Minister of Foreign Affairs at Paris:

> I must do justice to the marked worth and distinguished behavior displayed by M. Guerard, together with his conciliatory spirit and ability. He exercised upon his colleagues and the members of the Government (Egyptian) a legitimate influence, and has brought great esteem upon our flag by demonstrating once again the superiority of our engineers: He deserves the recognition and thanks of the Government of the Republic for the manner in which he has accomplished his mission.

M. Guerard is an officer of the Legion of Honor, and an officer of Public Instruction. On his numerous and always successful missions to other countries he has received a number of foreign decorations: he has been a grand officer of "Micham Ifstikar" since 1886, a grand officer of Osman in Turkey, of Civil Merit of Bulgaria, of the Crown in Roumania, Commander N. D. of the Conception of Portugal, of Mejidie of Turkey, an officer of the Crown of Iron of Austria-Hungary, of the Crown of Italy, of the Savieur of Greece, etc.

M. Guerard is Inspector General of the First Class, the highest grade that can be reached in the Corps of the Ponts et Chaussées. Besides having been for six years in charge of the inspection of the maritime ports and harbors of the Channel from Calais to the North Sea, which includes particularly the harbors of Rouen, of Havre, Dieppe, Boulougne, Calais, Dunkerque and the mouth of the Seine, he has also really been in charge of the inspection of the harbor of Marseilles and the other ports of the Mediterranean.

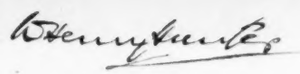
For over ten years M. Guerard has been a member of the International Consulting Commission on the works of the Suez Canal Co.

WILLIAM HENRY HUNTER.

William Henry Hunter, at present Chief Engineer of the Manchester Ship Canal, was born in 1849, and was educated at private schools in England and at the College of Physical Science at Newcastle-upon-Tyne.

After passing through the workshops he entered the office of the late Mr. Thomas Meik, M. Inst. C. E., (then engineer to the River Wear Commissioners) at the Harbor and Dock Works, Sunderland, and from there passed to the offices of Messrs. Meik and Nisbet, of Edinburgh and Sunderland, who were, *inter alia*, engineers to the new dock works at Boonetisland on the Firth of Forth and at Ayr on the Firth of Clyde. Mr. Hunter then became resident engineer on the works of the Aylton, Southwick & Monkwearmouth Railway in the County of Durham. In 1873 he was appointed assistant engineer to the River Wear Navigation in the County of Chester and was engaged on the works then carried on for the construction and enlargement of that navigation upon which the prosperity, if not indeed the very existence, of the salt trade of Cheshire depends.

In 1882, when the proposal for the formation of a maritime highway from the sea to the city of Manchester first took definite shape, Mr. Hunter became chief assistant to Mr. E. Leader Williams (now Sir Leader Williams) and worked out the project which ultimately found accomplish-



ment in the Manchester Ship Canal. He took part in the strenuous and protracted contests, extending over three years, which took place in both Houses of Parliament before legislative sanction was secured for the project. This was in 1885, when the Manchester Ship Canal act received the Royal Assent.

In 1887, when the Manchester Ship Canal Co. was formed, Mr. Hunter was appointed chief assistant engineer to the company and was directly concerned in all the engineering operations which were undertaken for or in connection with the actual construction of the waterway and auxiliary works. In 1891, Mr. Hunter was appointed chief engineer to the canal company. Since that time he has carried out all the works which have been constructed for the development of the Manchester Ship Canal and its adjuncts, including the great system of dock, railway and other works which were formally opened by His Majesty King Edward VII. on July 5, 1905.

In 1898, he was appointed a member of the *Comite Technique*, which was constituted in accordance with a special enactment of the French Legislature for the purpose of advising the New Panama Canal Co. and of preparing a scheme for the construction of the trans-isthmian canal; and which was international in its constitution.

In the present year Mr. Hunter was nominated, at the request of the President of the United States, by Lord Lansdowne, the Secretary for Foreign Affairs in the British Government, as a member of the Advisory Board, which is to consider the Panama canal project on behalf of the Government of the United States.

Mr. Hunter is a member of the Institution of Civil Engineers of England, a member of the Society of Arts, and of the Manchester Association of Engineers, a Commissioner for the Navigation for the Upper Mersey, etc., etc. He is recognized as the foremost English authority on canal construction.

ALFRED NOBLE.

Mr. Alfred Noble was born at Livonia, Wayne Co., Mich., in 1844. He was the son of Charles Noble, a farmer, and Lavina (Douw) Noble. His early education was gained at the country district schools near his home and at the village high school. In August, 1862, at the age of 18, he enlisted as a private in the 24th Michigan Infantry. He served continuously in the Army of the Potomac until February, 1865, and was then on post duty until June, 1865, when he was discharged, at the close of the war, with the rank of sergeant.

During the next two years Mr. Noble, while acting as clerk in the War Department, at Washington, prepared himself for admission to the sophomore class of the University of Michigan, which he entered in September, 1867. During his college course he was absent much of the time as recorder, clerk, and assistant engineer on lake,

A. Noble

river and harbor work for the United States. After graduating in June, 1870, Mr. Noble continued in harbor work under the U. S. Engineer Corps until the following October. He was then placed in local charge of the improvement of the St. Mary's Falls Canal and St. Mary's River, where he remained for twelve years, or until August, 1882. During this time the first great masonry lock at the Sault, then by far the largest canal lock in the world, was built.

From 1882 to 1894, Mr. Noble was engaged on a succession of important bridges, under such noted engineers as Bouscaren, Hutton, Morison and Corthell. Among these bridges were that over the Red River, at Shreveport, La.; several on the Northern Pacific, while Mr. Noble was general assistant engineer on that railway; the Washington steel arch bridge over the Harlem River at New York City; and the Cairo, Memphis, Leavenworth and Alton bridges.

In April, 1895, Mr. Noble was appointed by President Cleveland as the civilian member of the first Nicaragua Canal Commission. This was followed in 1899 by an appointment on the Isthmian Canal Commission, of that date, which recommended the Panama Route. Between his work on these two important canal commissions another notable service was rendered, this time on the second U. S. Deep Waterways Commission, which reported in favor of a 21-ft. channel from the Great Lakes to tidewater.

After serving on the Isthmian Canal Commission of 1899 Mr. Noble engaged for a time in private practice, being engaged on the Galveston sea wall and on the great bridge across the Mississippi at Thebes, Ill. In the latter work he was associated with Mr. Ralph Modjeski.

In 1903, Mr. Noble was appointed a member of the Board of Engineers organized to carry out the great work of the Pennsylvania R. R. in constructing a tunnel line under the Hudson River, Manhattan Island and the East River, to provide an all-rail entrance to New York city. As a member of this board Mr. Noble has charge, as Chief Engineer, of the section of the tunnel passing under the East River, with offices in New York City.

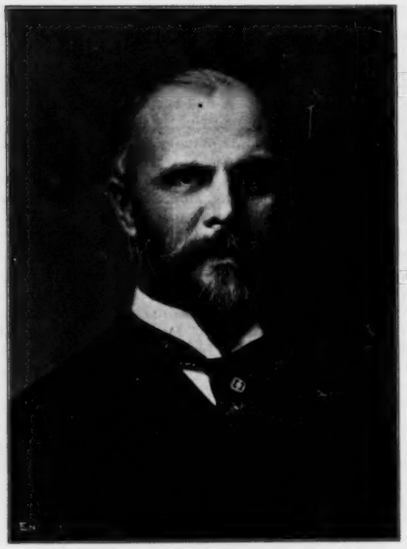
The honorary degree of LL. D. was conferred on Mr. Noble by the University of Michigan in 1895. He was President of the American Society of Civil Engineers in 1903, and before that of the Western Society of Engineers (1898). He is also a member of Institution of Civil Engineers of Great Britain, and of the Engineers' Club and the University Club in New York, and of the Chicago Club in Chicago. Some further details of Mr. Noble's activities may be found in the sketch published in this journal for Jan. 29, 1903, at the time of his election to the presidency of the American Society of Civil Engineers.

WILLIAM BARCLAY PARSONS.

William Barclay Parsons was born in New York City in 1859. After taking the degrees of A. B. and C. E., the latter in 1882, at Columbia University, he entered the Maintenance of Way Department of the Erie Railroad. Here he attained the position of division engineer, from which he resigned in 1885. He then began a general engineering practice, engaging chiefly in the preparation of plans for underground railroads projected in New York and in railroad and hydraulic work in different parts of the United States.

In 1891, Mr. Parsons was appointed Deputy Chief Engineer of the New York Rapid Transit Commission, and in 1894 he became chief engineer to the reorganized commission. In the latter capacity he prepared plans for the subway now in use, but owing to complications in financing the work construction was postponed. Meanwhile he went to China, in 1898, and made surveys for the Canton-Hankow R. R. Up to that time this was the longest instrumental survey made in the Chinese Empire.

In 1899, Mr. Parsons returned to New York and assumed charge of construction of the subway.



Wm. Barclay Parsons

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He continued as Chief Engineer of the Rapid Transit Commission until the subway was opened in 1904.

In 1902, Mr. Parsons designed the large dam of the Hudson River Water Power Co., at Spiers Falls, N. Y. In 1904, he served with Sir John Wolfe Barry and Sir Benjamin Baker as advisory engineers to the Royal Commission on London Traffic. During the same year, President Roosevelt appointed Mr. Parsons as a member of the Isthmian Canal Commission.

At present Mr. Parsons is consulting engineer to the following companies: Interborough Rapid Transit Co., the lessee of the elevated and subway railroads in New York; Hudson Companies, which are building the tunnels beneath the Hudson River; the New York, Westchester & Boston R. R., and the Susquehanna Water Power Co.

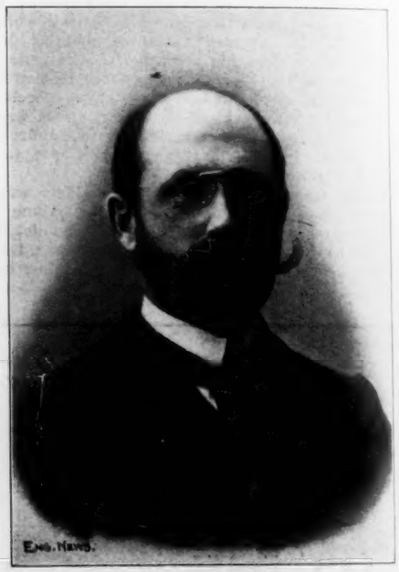
Mr. Parsons is a member of the American Society of Civil Engineers, the Institution of Civil Engineers of Great Britain, and the Society of Civil Engineers of France. During the Spanish-American War he served as Chief Engineer, New York National Guard, with the rank of Brigadier-General. He is the author of "Turnouts" (1885); "Track" (1885); and "An American Engineer in China" (1900).

EDOUARD M. QUELLENNEC.

Edouard M. Quellennec, Consulting Engineer of the Suez Canal, was born at Brest, Finistere, on July 28, 1856. He is a graduate of l'Ecole Polytechnique at Paris, Chief Engineer of the Ponts et Chaussées of France and, among other important positions, holds the office of Consulting Engineer of the Compagnie Universelle du Canal Maritime de Suez at Paris.

Mr. Quellennec began his engineering career under the French Government in the Department of Finistere, where he was engaged in the construction of secondary railways and on harbor works.

From France he went to Athens and entered the



E. Quellennec

service of the Government of Greece, as Chief Engineer of the Mission Francaise des Trauvaux Publics en Grèce. In this important position he built harbor works at the Pireaus, Patras, Kalamata and elsewhere, and also served as consulting engineer on the construction of the Corinth Canal.

Besides harbor and canal work in Greece, Mr. Quellennec worked out large projects for both the water supply and sewerage of Athens, and to crown his service in Greece he took a large part in the organization of the Department of Public Works and in the direction of all the public works done in that country during ten years.

In 1894, he was appointed Chief Engineer of the Suez Canal and exercised the duties of this office during seven years, in Egypt, at Ismailia. In this position he directed the work of enlarging and deepening the Suez Canal and the harbor of Port Said. Since 1901 he has been consulting engineer of the Suez Canal Company at Paris, with advisory voice in the Board of Directors.

In 1904, he was charged by the Government of the Island of Crete with the study of public works to be carried out in that island, and espe-

cially of harbor works. Finally, he is consulting engineer of the City of Alexandria, Egypt, for all the public works done in that great Mediterranean port.

Mr. Quellennec is Chevalier de la Legion d'Honneur, a Companion of the Most Distinguished Order of Saint Michael and Saint George, and has been decorated with numerous foreign orders.

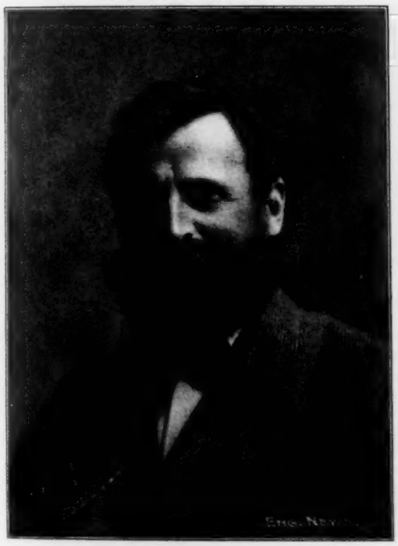
ISHAM RANDOLPH.

Isham Randolph, son of Robert C. Randolph, M. D., and his wife Lucy Nelson, was born on March 25, 1848, on a farm known as new Market, in Clark County, Va. At the time when he should have been enjoying the advantages of school the great civil war was raging and his home was in the debatable ground in the Valley of Virginia. Under these conditions his education devolved upon his mother, a woman of great force of character and cultivated mind. Apart from what she taught him his education in the schools was limited to twenty-one months in private schools near his home.

In 1868, he secured employment as an axeman on the Winchester & Strasburg R. R., a part of the Baltimore & Ohio system. After the location he continued on that work as rodman until its completion. In 1870 he was leveler on the surveys for the Washington & Ohio R. R., extending from Round Hill, Loudon Co., Va., to Winchester, Va. In 1871 he was transitman on the survey for the extension of the Lehigh Valley R. R. from Jugtown Mountain to Perth Amboy, N. J.

In March, 1872, he re-entered the service of the Baltimore & Ohio R. R., as transitman in the extension of that line to Chicago. In this capacity he located the line from Syracuse, Ind., to Chicago. Later, as resident engineer, he built 27 miles of this line and the roundhouse and shops at South Chicago.

In 1878, he entered the service of the Scioto Valley road as assistant engineer, and later became roadmaster of that line. In 1880, he went to Chi-



Isham Randolph

cago as Chief Engineer of the Chicago & Western Indiana & Belt Railway of Chicago. Here he had extensive experience in the building of railroad terminals, freight houses, round houses, etc.

In 1885, he opened an office for general engineering work in Chicago. In 1886 he was employed by the Illinois Central R. R. in the location and building of the Chicago, Madison & Northern R. R. and the Freeport & Dodgeville Line, as chief engineer. In 1888, he resumed the general practice of engineering in the city of Chicago and was employed as engineer on various projects, and later as consulting engineer for the Union Stock Yards & Transit Co., and the Baltimore & Ohio R. R. Co.

On June 7, 1893, he was elected Chief Engineer of the Sanitary District of Chicago and has continued as such ever since. At the time of his election 600,303 cu. yds. of glacial drift had been excavated and 391,335 cu. yds. of solid rock. The total expenditures at that time amounted to $558,023. The total excavation of the artificial channel and river division, now completed, amounts to 30,845,290 cu. yds. of glacial drift and 13,106,566 cu. yds. of solid rock, and the erection of 388,405 cu. yds. of retaining walls. The total expenditures for construction and engineering up to June 1, 1905, amounted to $30,782,466, of which $30,224,444 has been expended under his direction; this has also included the improvement of the Chicago River, the building of 13 railroad and 22 street and highway bridges.

Mr. Randolph is Past President of the Western Society of Engineers and a Member of the American Society of Civil Engineers.

He was married June 15, 1882, to Mary H. Taylor, and has a family of three boys, Robert Isham, born April 14, 1883; Oscar de Wolf, born Sept. 28, 1885, and Spottswood Wellford, born Aug. 7, 1892.

JOSEPH RIPLEY.

Joseph Ripley was born at St. Clair, Mich., Jan. 3, 1854. He was the fifth and youngest son of Volney A. and Maria Klein Ripley, who were both natives of central New York. From 1855 to 1876

Joseph Ripley

his home was at Pontiac, Mich., and since then he has lived at Sault Ste Marie, Mich. He graduated from the high school in 1872 and from the civil engineering course in the University of Michigan in 1876, after which he practiced for a few months as land surveyor.

Since 1877, Mr. Ripley has been employed almost constantly on canal and river work at Sault Ste Marie. In 1877-8 he was inspector of masonry on the Weitzel lock; 1879-82, assistant engineer on St. Mary's River improvements; 1882-97, first assistant engineer canal and river improvements; and since 1898 General Superintendent of the St. Mary's Falls Canal. In 1897, Mr. Ripley had charge of a survey for a canal designed to connect Birmingham, Ala., with the Warrior River (House Doc. No. 88, 55th Congress, 3d Session).

Mr. Ripley joined the Michigan Society of Engineers in 1883; the Western Society of Engineers in 1896, and the American Society of Civil Engineers in 1901. Aside from a few papers before the Michigan Society his writings have been confined to official reports relating to canal and river improvements, and those, with the exception noted, have all related to the great work at Sault Ste Marie. On this and related work the U. S. Government has expended $11,000,000 since 1870, and now has in hand improvements estimated to cost $10,000,000. The latter include a new lock 1,200 ft. long and 75 or 80 ft. wide with 25 ft. of water on the miter sills. Contracts for dredging and rock excavation amounting to over $4,000,000 are being vigorously prosecuted at the present time.

FREDERIC PIKE STEARNS.

Frederic Pike Stearns was born in Calais, Me., Nov. 11, 1851, and is a lineal descendant of Isaac Stearns, who came to this country as a member of Governor Winthrop's party and settled in Watertown, Mass., in 1630.

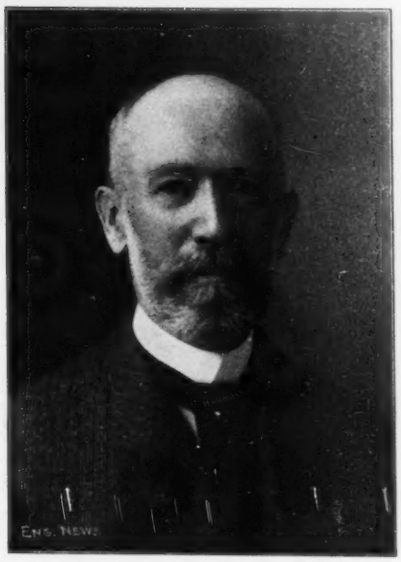
He was educated in the public schools of his native place, and then came to Boston, where, in 1869, he entered the engineering department of the city of Boston, and also began a course of study along technical lines.

From 1872 to 1880, he was engaged upon the investigations for and the construction of the additional water supply for the city from the Sudbury River. During the construction of the works he held the position of division engineer. It was during the construction of these works that, in connection with Alphonse Fteley, Resident Engineer, he carried out an important series of hydraulic experiments, the results of which are contained in a paper presented to the American Society of Civil Engineers in 1882, for which the Norman Medal for that year was awarded.

In 1880, Mr. Stearns was transferred to the main drainage works of the city of Boston, then under construction, and was given immediate charge, as division engineer of the tunnel under Dorchester Bay and the reservoir and other outlet works. When the works were put in operation he became the executive engineer in direct charge of the whole system.

In 1886, he resigned the last-named position to become the Chief Engineer of the Massachusetts State Board of Health, and continued with that board for nine years. During this time he had occasion to investigate and report upon water supply and sewerage systems throughout the State, to make certain reports in connection with an investigation for a main sewerage system for the Mystic and Charles River valleys, and to investigate and report upon a water supply for the Metropolitan District.

He also acted in 1893-94 as chief engineer of a joint board, consisting of the State Board of Health and the Metropolitan Park Commission-



F. P. Stearns

ers, on the improvement of Charles River, and recommended the construction of a dam near Craigie Bridge to create a fresh water basin to be maintained at a constant level. This work is now being executed in substantial accordance with his recommendations.

From 1895 to the present time he has been chief engineer of the Metropolitan Water Board and its successor the Metropolitan Water and

Sewerage Board. While holding this position he has had charge of the construction of the Metropolitan Water-Works, which are well known to the readers of this journal. These works have been built in the most thorough manner and are now substantially completed without exceeding the original estimate of cost. They supply water to Boston and 19 of the surrounding cities and towns.

In addition to his regular engagements, Mr. Stearns was, in 1889, a member of a Board of Sanitary Engineers to devise a system of sewerage for the District of Columbia. He was one of the consulting engineers of the first Rapid Transit Commission of Boston, in 1892, and is now the consulting engineer of the Charles River Basin Commission and also a member of a board of consulting engineers to the Baltimore Sewerage Commission.

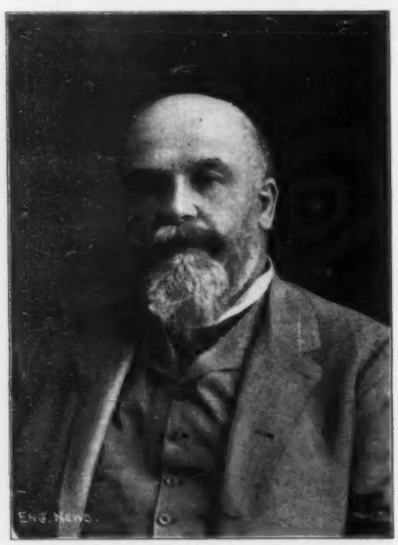
He is a member of the American Society of Civil Engineers, of which he has been director and vice-president, and of the Boston Society of Civil Engineers, of which he has been president. He has occasionally contributed to the publications of these societies, the more important contributions, in addition to that already mentioned, being as follows:

To the American Society of Civil Engineers, in 1883, a paper "On the Current Meter, Together with a Reason why the Maximum Velocity of Water Flowing in Open Channels is below the Surface"; in 1884, a paper giving the results of "Experiments on the Flow of Water in a Forty-eight Inch Pipe"; and in 1902 a description of the North Dike of the Wachusett Reservoir, which was presented as a part of a discussion upon the Bohio Dam of the Panama Canal. To the Boston Society of Civil Engineers, in 1891, a paper on "The Selection of Sources of Water Supply."

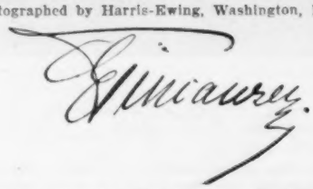
On Commencement Day of this year Harvard University conferred upon Mr. Stearns the honorary degree of Master of Arts.

EUGEN TINCAUZER.

Eugen Tincauzer, after graduating from the University School of Technology at Berlin, en-



Photographed by Harris-Ewing, Washington, D. C.



tered the Prussian division of the government service and spent his first four years as an engineer on construction works at Kiel. After this preliminary work at Kiel, he passed through the final government examination to the grade of Baumeister (Master of Construction). He spent the next four years at the naval harbor of Wilhelmshaven in Prussia, where he was engaged in supervising the construction of naval works and general harbor improvement. Following this he was called to assist in the construction of the great Kaiser Wilhelm Canal, which, extending from Kiel to the River Elbe, connects the North and Baltic Seas. Mr. Tincauzer was engaged on this work, which has a length of 50 miles and involved an expenditure of $40,000,000, for eight years, from 1888 to 1896.

Mr. Tincauzer was next employed by the government at Stralsund, on the Prussian Baltic Coast, as inspector of all engineering works and fortifications along this coast and that of the island Rugen. He also directed the erection of sea walls, of harbors, and other naval improvements along the Baltic Coast.

The last great work upon which this eminent German engineer was engaged was the completion of the Königsberg Sea Canal, a canal giving direct passage for ships of 5,000 tons from the sea to Königsberg, a distance of some twenty miles. Mr. Tincauzer took this work in hand after it had been begun and carried it to a successful termination. Then, under his direction a great sea wall was built at Memel, and several smaller harbors have been begun under his supervision.

Mr. Tincauzer now resides at Königsberg in Prussia, where he is a member of the Government. He has the direction of and control over all the engineers on the sea-coast and at the two harbors of Pillau and Memel.

JOHAN WILHELM WELCKER.

Johan Wilhelm Welcker, who comes as the representative of the Netherlands Government, was born in December, 1845, at Arnhem, Holland. He took a course in engineering at the Polytechnic School at Delft in 1861-66, and, having passed the final examinations, he received his diploma in September, 1866. In May, 1867, he entered the Corps of Engineers of the Waterstaat, and a short time later he was charged with the local direction of the great work necessary for the construction of a new tidal river, called to-day the Nieuwe Mervede, a branch of the Rhine, which replaces a labyrinth of natural outlets.

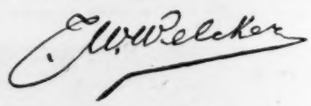
In 1873, Mr. Welcker was appointed an engineer in the central service of the Waterstaat at The Hague, the capital of the kingdom, as assistant engineer in the work of organizing and exercising the general direction of the principal rivers of the kingdom, the complete correction of which was decided and undertaken at that time. In this work he continued nearly eight years, until April, 1881, when he was assigned as a resident engineer in the province of North Holland, with residence at Alkmaar.

He accompanied the late Mr. Caland, Inspector General of his Corps, to Brazil in 1885, in response to an invitation of the Brazilian Government to deliver a report and give advice on the construction of a great seaport for trans-atlantic steamers at Rio Grande do Sul, in the extreme south of that country, between the Lagoa dos Patos, and the Atlantic Ocean. After this mission was accomplished he resumed his service at Alkmaar until June, 1888, and was then appointed resident engineer for the new waterway from Rotterdam to the North Sea. During the four years that he served on this work several important undertakings for the accomplishment of this great waterway were consummated, especially the cut of the great curve in the stream at Maassluis, half way between Rotterdam and the sea, and the expensive dredging works at Hoek van Holland between the great jetties at the entrance of this waterway into the North Sea.

In February, 1892, he was charged with the general direction of the hydraulic service in the province of Overlyssel, with his residence at Zwolle. During that time he prepared a plan for the correction of the river called the Vecht, between the German frontier and the Zuyder Zee (which plan has been since carried out) in order to prevent, what formerly was very frequent, the inundations of the adjacent parts of the province by that river in summer time.

In 1892 he was appointed a member of the Royal State Commission for studying and working out a complete plan for draining the Zuyder Zee, a plan which, when carried out, will add a great new province to the kingdom. It was not until 1894 that this Commission could achieve its great task and deliver its voluminous report to the Queen-Regent.

In November, 1900, he was again assigned to the service, as a chief engineer at The Hague, of directing the general correction of the principal rivers of the kingdom, which service he left in October, 1903, after having prepared the final plans for leading the River Maas in a separate bed to the sea. Since then, Mr. Welcker has been charged with the general direction of the hydraulic service in the province of South Hol-



land. The construction of the new seaport at Scheveningen, on the sandy North Sea beach, is a part of that service.

In 1898, the late Mr. Conrad, General Inspector of the Waterstaat, and Mr. Welcker were invited by the city of Antwerp to give their advice on the projected great cut of the bend of the River Scheldt below that city, and on the question to what extent the interests of trade and sea navigation of that great harbor would justify this project. They accomplished their task by delivering two reports, in 1899 and 1900, to the city council.

Mr. Welcker is a Chevalier in the Order of the Netherlands Lion, and was a delegate from his government at the International Congress of Navigation at Paris in 1892 and at Düsseldorf in 1902. He is a consulting member of the Batavian Scientific Society at Rotterdam, and was three times chosen as a member in council of the Royal Netherlands Institute of Engineers, of which Institute he was afterwards made chairman, from 1903 to 1905.

Mr. Welcker has published a study on the derivation of the high waters of the River Leck, one of the arms of the Rhine, through the dikes on the left bank of that river.

THE CANTON-HANKOW RAILWAY, an American enterprise, has been acquired by the Chinese government. The price agreed upon is said to be $6,750,000. The original concession was granted in 1899 to a syndicate headed by the late Calvin Brice. The railway was planned to extend from Hankow, on the Yang-tse-Kiang, south to Canton, on the Pei-Ho, a distance of 742 miles, but only about thirty miles has been built. Mr. Wm. Barclay Parsons located the road when he was its Chief Engineer, some years ago. Local opposition to the construction of the road was very great, so great that construction was stopped when the above-noted length was completed. Report has it that the road will now be built complete, as planned, and may also be extended north from Hankow to Peking. A description of Mr. Parson's survey appeared in Engineering News of June 15, 1899, and other articles on the road were published in our issue of Jan. 14 and March 17, 1904.

THE GINN FIELD TIMBER FOOT-BRIDGE, BOSTON METROPOLITAN PARK SYSTEM.

By Wm. T. Pierce,* M. Am. Soc. C. E.

The design of this small wooden foot-bridge, shown in the accompanying drawings, gives a simple structure of pleasing lines and one adapted to the location. It crosses the Aberjona River at the upper end of Ginn Field, a portion of the Winchester section of the Mystic Valley Parkway. Sufficient headroom is given for waterway during freshets and also for the boating along this stretch of slack water extending up from the Upper Mystic Lake.

The clear span is 40 ft. 4 ins., the rise above springing line is 6 ft. and the width between

Fig. 1. View of Timber Foot-Bridge, Metropolitan Park System.

trusses is 5 ft. The intrados of the river opening was given a curving line at the suggestion of the Commission's architect. The type of the bridge is a combination of a King truss and an arch. The center curving portions of the arch, or floor stringers, were built up of 2-in. plank for reasons of economy. The middle stringer is supported from the outer trusses by hanger irons and braces at center of bridge and at two other points, each 12½ ft. in from the ends. The bridge was built in 1902 by day work and, as far as practicable, by the regular laborers employed under the superintendent on this parkway and the nearby Middlesex Fells Reservation. The lumber used in the structure was all kyanized spruce of extra quality, cut to exact sizes and shapes at the mill before treatment to the bi-chloride of mercury. In assembling, the ends of all timbers which butt together were given a good coat of lead and the finished structure was given two coats of paint. The kyanized lumber was furnished by the Berlin Mills Co. of Portland, Me.

The cost was as follows:

Abutments:			
Labor		$197.14	
Materials, stone and cement		113.23	
			$310.37
Superstructure:			
Materials, 3,010 ft. B. M. of kyanized lumber, millwork & freight	$158.74		
Ironwork	78.10		
Paint	18.00		
Extra tools	11.20		
		$266.04	
Labor, erection	$87.38		
Extension guard rails	9.48		
Painting	37.80		
		$134.66	
			$400.70
Total			$711.07

*12 Russell Ave., Watertown, Mass.

SOME PRACTICAL POINTS IN THE DOUBLE TRACKING OF RAILWAYS.

Among the many important improvements now being made upon existing railways is the double-tracking of certain portions of the lines to improve or increase the facilities for handling traffic. Some of the economic and practical questions relative to the necessity for and the advantages of double tracking railways carrying heavy traffic are discussed in our editorial columns, together with the relation of double-tracking to other improvements. The important conditions which limit or determine the capacity of single-track lines are the grades, the sidetrack facilities, and the number and character of the trains. On these points we present expressions of opinion from three important lines which have done a large amount of double track work:

PENNSYLVANIA LINES.—With regard to double tracking, the problem is a very interesting one, though quite complicated. We generally figure that when the number of trains on a division reaches 60, with 20% passenger trains, it is time to consider double-tracking the entire division. This refers to the conditions as we generally find them on our through east and west lines in this part of the country, with undulating grades up to 1%, thus resulting in short freight trains and quick movements.

The above, of course, is based on the assumption that ample terminal facilities have been provided at either end of the division. Generally, we find it necessary to provide a short stretch of second track at either end of a division before the traffic attains the proportions above referred to. The estimate is also based upon ample passing facilities throughout the division, which generally consist of lap sidings spaced five miles apart. On the Indianapolis Division, between Columbus and Bradford, O., we are handling daily 14 passenger trains, 10 fast freight and stock trains and 40 regular freight trains. This portion of the road is now double tracked for a distance of about 30 miles, and the remainder will be double tracked within a year or two.

The conditions as to gradients and character of traffic have a very important bearing on the subject, and it is often necessary to provide additional main-track facilities much sooner on low-grade divisions having the unfortunate combination of a mineral freight traffic and a high-class passenger traffic. For instance, on portions of our line between Pittsburg and Cleveland, we have already provided second track where the average number of trains does not exceed 40, but the grade is practically level and we consider it economical to haul very long freight trains, even though this necessitates an earlier expenditure for main track facilities in order to provide for the sluggish freight movements and at the same time avoid delay to important passenger trains. On the other hand, we have a division where the train movement frequently runs as high as 65, but it has not been necessary to double track it throughout for the reason that the freight traffic is principally high class, the trains are short, and the movement very prompt.

We have also found in this connection that on sections of the line where we have reduced the grades, say from 0.7% to 0.3%, it has been economical to lay an additional track for freight trains on the extended grades resulting from this reduction. Thus, on the division between Logansport and Chicago, where the grades have recently been adjusted to 0.3%, and where the traffic hardly warrants a double track throughout, we have constructed sections of double track on these long grades, to be used by freight trains in ascending the grades.

BALTIMORE & OHIO RY.—It is very difficult to assign any specific conditions under which the building of a second track is justified. It is not so much the amount of business that is handled as the character and variety of the business. It is seldom that a whole division is double tracked at one time. The beginning is usually made by building a stretch of double track outside of the yards, and this is extended from time to time, the extension being governed by the apparent needs from a train dispatching standpoint, or by the financial ability of the company. Sometimes a piece of double track is built in some busy district near the middle of the line (or division), or at points where there are heavy grades, or where pusher engines are used. Afterwards the various sections of double track are extended and finally connected together, the whole process extending over an indefinite time. The double tracking we are now doing consists of small stretches built for various reasons, but in none of these cases is the total amount of traffic the prevailing factor.

UNION PACIFIC RY.—In regard to the limiting or determining conditions which lead to the double tracking of individual portions or divisions of a railway, 50 trains per day is considered the limit for single track. Even in this statement, the question of grades and the manner in which the trains are moving is a very deciding factor. In other words, on low grades we can operate 30 trains where it would require 50 trains to handle the business on heavier grades. In fact, we have just such a condition on our line where, with 30 trains running, we can get along without double track, but where with 50 trains in operation double tracking is necessary.

In regard to the handling of trains on single track roads it is of interest to note that in 1882 the late Mr. Wm. P. Shinn (then Superintendent of the Pittsburg, Fort Wayne & Chicago Ry.) read two papers before the American Society of Civil Engineers on the subject of "Increased Efficiency of Railways for the Transportation of Freight." In one of these he stated that the length of his road between Pittsburg and Chicago was 468 miles (with 74 miles of double track and 185 miles of sidings; its traffic averaged 30 trains each way per day. In 1806, when the Illinois Central Ry. commenced the double tracking of a busy section of its line north of Cairo (having numerous curves and steep grades) there were 50 passenger trains daily. This work is referred to more fully later on. A case is reported where 70 trains were handled daily on a single track; 10 of these were passenger trains, but if these had numbered 20 or 25 the conditions would have been very different. In another case 70 local passenger trains and 10 freight trains were handled daily over a 15-mile stretch of single track with six sidings, and without very much trouble (although the movements were necessarily somewhat complicated). On the other hand, a line with 50 to 60 trains daily was doubled, for the reason that a considerable proportion of the traffic consisted of stock trains, which must be handled promptly and at certain hours, and therefore must not be held on side tracks more than is absolutely necessary. The same applies in part to fast freight trains.

In the double tracking of a stretch of 12 miles of the Eastern Division of the Boston & Maine Ry., the general plan adopted was first to have the bridge and culvert masonry below grade done by contract. The grading and rock excavation at all points where teams could be used to advantage was then done by contract; and then the railway did the excavation and filling to subgrade at points where steam shovels and work trains could best be used. In 1896 and 1897 the Illinois Central Ry. undertook the double tracking of 28 miles of a difficult part of its line north of Cairo, built through a chain of hills and having 43% of the distance on curves, no tunnels having been used. The heaviest curves were of 5°, but were combined with heavy grades, including one of 45 ft. per mile for a length of seven miles. With this combination and with speeds varying from 10 to 50 miles an hour it was extremely difficult to obtain a curve superelevation which would allow heavy trains to ascend without stalling and fast trains to descend without

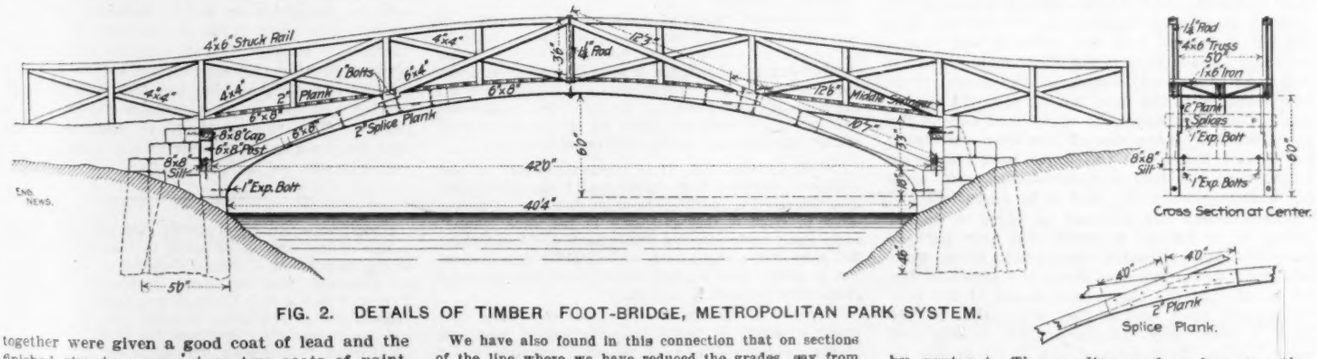


FIG. 2. DETAILS OF TIMBER FOOT-BRIDGE, METROPOLITAN PARK SYSTEM.

being derailed. This difficulty was of course eliminated when trains in only one direction had to be provided for on each track. The alinement was not materially changed, but the widening was done partly on one side and partly on the other side of the old line, which enabled some improvements to be made. At the time when this work was decided upon, there were 50 passenger trains daily over this piece of line, and serious delays were caused by holding trains so as to ensure safety in operation. At the same time, the wear and tear on the track was very severe, but there was little time available for maintenance and repair work. An interesting and important piece of work of this kind which it is said will probably be commenced next year is the double tracking by the Canadian Pacific Ry. of its line from Winnipeg (or even from some point west of that city) to its lake terminal at Fort William; this is necessitated by the enormous growth of the wheat traffic, the handling of which has become a difficult problem.

The work of double tracking often involves tunnels and large bridges, and requires the moving of stations and buildings, the rearrangement of yards and sidings and other similar work. The widening of large bridges and tunnels is a difficult matter, and comparatively few of our very large bridges have double track. Foremost among these is the new Thebes cantilever bridge over the Mississippi River (Engineering News, May 11, 1905), but this bridge was built to accommodate an existing heavy traffic. The Illinois Central Ry. has been double tracking different parts of its main lines during the past few years, and considered this matter in the construction of its new bridge over the Tennessee River near Gilbertsville, Ky. In view of the eventual double tracking of the line between Louisville and Fulton, it was necessary to provide for double tracking this large bridge without interfering with traffic. The plan adopted for the bridge was to build the piers and the 450-ft. swing span for double track and the fixed spans (three of 300 ft. and two of 150 ft.) for single track. These latter spans, however, have each one light truss and one heavy truss; the heavy truss is on the center line of the bridge, and in double tracking another light truss can be erected and a floor system put in without interfering at all with the older part of the structure. The drawspan had to be made of rather unusual width to allow for the spacing of tracks on the three-truss fixed spans. In double tracking the Cleveland division of the Baltimore & Ohio Ry., the Barton tunnel (455 ft. long) was widened. The old single-track tunnel was timbered and a heading driven above it, the new heading being timbered for the full size of a double-track roof, with the springing line on one side just outside that of the old tunnel. When a length of tunnel was completed, the second track was extended to the face, for the removal of material. In a few cases the upper part (above the springing line) of a tunnel has been excavated for double track and the lower part for single track, thus avoiding any subsequent roof work for widening when the line is in operation.

Where banks are widened to carry a second track, it is better to build the new part in horizontal layers from a construction track, than to simply dump material down the slopes of the old bank. In the latter case, much of the material rolls away and is lost, while that in the bank is loose and unstable, liable to slip and wash, as has been pointed out in an article on "The Construction and Maintenance of Railway Embankments" in Engineering News of Oct. 9, 1902. For such work, the plowing of the slope before the bank is widened is sometimes required, and the specifications of the American Railway Engineering and Maintenance of Way Association provide that in widening embankments the slope of the old bank "must first be deeply plowed in order to bond the new material thoroughly to it." In practice, however, this provision is very frequently neglected, even for high banks, and the surface crust or the covering of grass prevents any effective bonding of the new and old material. Where the bank is built in horizontal layers, as above noted, and which method has been adopted in some recent work, a construction track is laid along the ground at the foot of the old bank and material dumped from small contractors' cars, or shoveled or plowed from railway cars. The track is raised as the work progresses, and the material is thus consolidated by the weight of the trains passing over it, while at the same time the running track on the old bank is not interfered with by the gravel trains while unloading, as these trains are switched onto the construction track. In the case of trestles, it is customary to fill them in double tracking, depositing the material from work trains on the trestle; while scrapers and teams are often used in conjunction to grade the bottom and distribute the dumped material in order to keep the surface of the fill approximately level.

On double-track lines, the width between centers of tracks is usually 13 ft., but is sometimes as low as 12 ft. or as high as 14 ft. The Pennsylvania Lines formerly had a spacing of 12 ft. 2 ins., but owing to the increase in width of cars it increased this to 13 ft., the change involving considerable expense. On the other hand the New York Central Ry. has reduced its spacing from 13 ft. to 12 ft., but uses this latter only for new construction, leaving the tracks unchanged where they already have a 13-ft. spacing. This spacing was discussed at some length at the annual meeting of the American Railway Engineering and Maintenance of Way Association, and a spacing of 13 ft. finally adopted for recommendation.

One of the important points for consideration in plans for double tracking is the cost of the work, and many attempts have been made to establish a relation between this cost and the original cost of the single-track line. It is impossible to do this with any degree of reliability, however, as we have shown elsewhere, owing to the varying character and conditions of the work. This is shown also by the statements quoted below:

CLEVELAND, CINCINNATI, CHICAGO & St. LOUIS RY.—As to the comparative cost of double track and of single track line, and of the cost of double tracking a single-track line, local conditions vary so greatly that it seems impossible to give a definite or a general answer. For example: in the recent work of double tracking our line between Cincinnati and Indianapolis we found it advisable to relocate about 20 miles of the line, and there was one mile of this which cost $375,000. There have been many miles of double-track road that we have built in portions of Illinois and Ohio where the total cost has not exceeded $40,000. The same local conditions would make it impracticable to say just what proportion of the original construction cost the cost of double tracking a single line would be.

On a five-mile change of grade out of Indianapolis, on our Chicago Division, we estimate that we can build an entire new double-track line, five miles long, including right-of-way and elimination of several street grade crossings, for a less amount than we could double track our five miles of existing line. In this particular location our new line is a tangent line, while our old line has a great deal of curvature and a large number of bridges.

UNION PACIFIC RY.—It is impossible to give the cost of double tracking a single-track line. It depends entirely upon the country, and it seems to me that no good answer could be given to that question. In the same country, under same conditions, the double track would cost about 35% more than a single track road. Definite figures about cost of double track are also entirely dependent upon the character of the work to be done.

CHICAGO & ALTON RY.—The cost of railway construction, single or double track, is largely influenced by the standards that are in use on any particular line and the topography of the country through which it passes, so it seems to me that no general or average figure could be given that would be at all reliable as to the cost of the work.

We have an actual case just now which will furnish one very good illustration. We are building a new line in Illinois for single track which is 34.56 miles in length. Our standards require 80-lb. steel rail, heavy Weber joints, 3,000 yds. stone ballast per mile, and 2,900 ties per mile. Culverts are of cast-iron pipe or concrete, and bridges of concrete or concrete abutments with steel girders. I should state that the structures on this particular line are of no very great importance and do not cut a very large figure in the total cost. Our track construction above subgrade costs us complete per mile $10,494; earth work for single track per mile, $4,875; structures, $3,242 per mile; right-of-way (approximately), $9,600 per mile. These are very close figures and include everything but engineering and contingencies. It should be noted that the maximum grade of this line is 0.3%, that it is a tangent line for the entire distance, and that there are three railway crossings, at each of which a separation of grades is being made. This will give you a good idea of the character of the line. If now this line were to be double tracked after completion the cost per mile for track complete above subgrade would be double. The cost for earthwork would be increased about 55%, right-of-way would not come in the calculation at all, and the structures would be increased not more than 50%. From this it will be easy to calculate the percentage for double tracking a line of this character, and you will get a very close result.

Concerning the question as to the conditions which determine double tracking of an individual portion of a single track line, the conditions which determine the question on our road are not quite the same as those on other lines, similarly located in this territory, from the fact that it is notably a passenger road and derives more money from its passenger earnings than from its freight. It may be said in a general way that when traffic on a single line becomes so congested that it cannot be moved with promptness and safety, the time has come for the construction of a second track. This may be, and often is, put off. The season when traffic is congested lasts not more than six months out of the year. Many roads are compelled to worry along the best they can until the time comes when they can best afford to spend the money for new construction, or they are actually compelled by pressure to delays or accidents to add to their facilities.

In time the traffic of a certain portion of a railway may become too great for double tracks, and a third relief track or two additional tracks will have to be build. When this occurs the four tracks are usually on the same right of way, but it may sometimes be found more advantageous and economical to build the additional tracks as an independent double-track line. This plan has been adopted in increasing the capacity of the Chicago and Milwaukee line of the Chicago & Northwestern Ry. The original line (85 miles long) follows closely along the shore and passes through a number of towns which are largely the homes of Chicago business men. It is double-track throughout, but the rapid growth of local and suburban passenger traffic has made it difficult to properly handle the heavy freight traffic and fast through trains, so that additional facilities have become necessary. To widen the existing line would mean heavy expense for right of way through the numerous towns and for bridges, track elevation, alterations to existing works, etc. It was eventually decided, therefore, to build an independent line a few miles west of the original line, passing through a farming country with practically no towns to be provided for. This line is already in operation for about 30 miles, connecting with the old line at Lake Bluff; and will be completed as far as Kenosha, Wis., (52 miles) this year. This is specially for freight traffic and through trains, and has not only the advantage (for this special purpose) of avoiding centers of population, but has also such favorable grades and curves that heavier trains can be hauled. With this relief line in operation it will also be practicable to shorten the time of passenger trains on the present line.

A TESTIMONIAL REGARDING THE FRASER RIVER bridge in the form of an order in council was passed by the Government of British Columbia on April 29 and has since been presented to the engineers of the bridge, Messrs. Wadell & Hedrick, of Kansas City, Mo. The testimonial recites briefly the location, purpose, character and cost of the bridge; it states that in both design and construction "engineering abilities of the highest order were required;" and bears witness to the ability and integrity with which the work was performed. It is signed by R. F. Green, Chief Commissioner of Land and Works.

A STEEL DAM 75 to 80 ft. high is to be built across the Missouri River at Helena, Mont., for the Helena Power Development Co., and will be the highest dam of this type yet built. It was designed by Mr. J. F. Jackson, Assoc. M. Am. Soc. C. E., of Houghton, Mich., who was also connected with the construction of the two dams of this type now in existence. These are the Ash Fork dam in Arizona (Eng. News, May 12, 1898), and the Redridge dam in Michigan (Eng. News, Aug. 15, 1901). These have maximum heights of 46 ft. and 74 ft. respectively, and each consists of a series of steel bents supporting an inclined face of steel plates, the face construction being according to the patented system of Mr. F. H. Bainbridge.

THE PENNSYLVANIA R. R. TUNNEL UNDER CAPITOL HILL, WASHINGTON, D. C.

An example of soft ground tunneling notable in the use of labor-saving appliances is furnished by the work being done in piercing Capitol Hill for the Pennsylvania R. R. entrance to the new Union Station now under construction at Washington, D. C. In this work a large part of the excavation, the hoisting and conveying of materials, and the backfilling of the excavation is being done by machinery. This machine work is, moreover, being prosecuted in materials which require to be very heavily timbered to prevent movement and damage to important buildings located over the tunnel line. Through the courtesy of the contractors for the work, which is now well advanced, we give here details of the methods of excavation and of the machinery employed.

DESCRIPTION OF TUNNEL.—The accompanying map, reproduced from our issue of Nov. 10, 1904, shows the location of the tunnel in relation to the new station and to familiar local features. As will be seen, it forms the southern approach to the station, passing under First St., with its southern portal located at New Jersey Ave. and D St., southeast, and its northern portal in the basement of the new station building. The tunnel is 4,000 ft. long, and provides for two railway tracks in separate tubes. The cross-section is indicated by several of the accompanying drawings. Briefly described, the total width is 48 ft. and the total height is 24 ft. The tube for each track has a clear width of 16 ft. and a clear height of 20 ft., and the two tubes are separated by a wall 4 ft. thick. This center wall is of stone masonry, the side walls are of concrete, and the arch ring is brick backed with concrete.

A notable feature of the lining construction is the means of waterproofing and drainage adopted for the roof or crown. To ensure drainage the concrete covering of the roof arches is provided with gutters connecting with drain pipes spaced 50 ft. apart and leading to subgrade. On top of the concrete covering there is laid a waterproof coating, consisting of alternate layers of coal tar pitch and Hydrex felt; four layers of felt and five layers of pitch. In the open cut-work, about 1,600 ft., this waterproofing is protected by a coat of mortar, but in the tunnel work proper the protection consists of a layer of brick laid in mortar. These details are indicated in the drawings.

MATERIALS PENETRATED.—The material overlying the tunnel consists mostly of gravel. This contains, at an elevation of about 20 ft. above subgrade, a layer of white sand of varying thickness; in places it reaches well below subgrade. Underlying the sand is a stratum of hard blue clay, which in places extends several feet above subgrade. The gravel and sand overlying the clay carries a large amount of water, and when saturated the sand is practically a quick-sand. To conduct excavations with any success, therefore, required thorough drainage. This was accomplished chiefly by driving and sheeting two 6 × 8 ft. shafts on the line of the tunnel, one 1,800 ft. and one 2,700 ft. from the south portal, and sinking them well below subgrade to form sumps, from which the water is pumped by pulsometers. When thus drained the sand is excavated with comparative ease.

Before passing the matter of materials penetrated, it is important to note that the line of the tunnel passes under or close to several important buildings. One of these, as will be observed from Fig. 1, is the monumental Congressional Library; the tunnel comes nearly under the elaborate fountain in front of the entrance steps to the library. The new office building of Congress is a second structure which, when completed, will come directly over the tunnel, and here for a distance of about 600 ft. a special reinforced lining construction has been adopted. Briefly, the masonry center wall is carried up to a point above the crowns of the arches, and the concrete side walls are similarly extended upward by masonry to form supports for 24-in. I-beams set 18 ins. apart transversely across the tunnel. The spaces between the walls and over the arches are filled with concrete so as thoroughly to embed the I-beams.

METHOD OF EXCAVATION.—As previously stated, some 1,600 ft. of the tunnel mostly at the south end were built in open cut; the remaining 2,400 ft. are being constructed underground by true tunneling methods. The underground work alone calls for special attention. Here the treacherous material penetrated made it unwise to open the full width of excavation required to construct the two tubes simultaneously, and the plan was adopted of building each tube separately. Accurately speaking, a section is first opened wide enough to permit of constructing the side wall and arch of one tube and the center wall between the tubes, and after this masonry is completed a second parallel excavation is opened for the construction of the side wall and roof of the second tube. The sequence of operations is best explained in connection with the drawings of Figs. 2 to 10 inclusive.

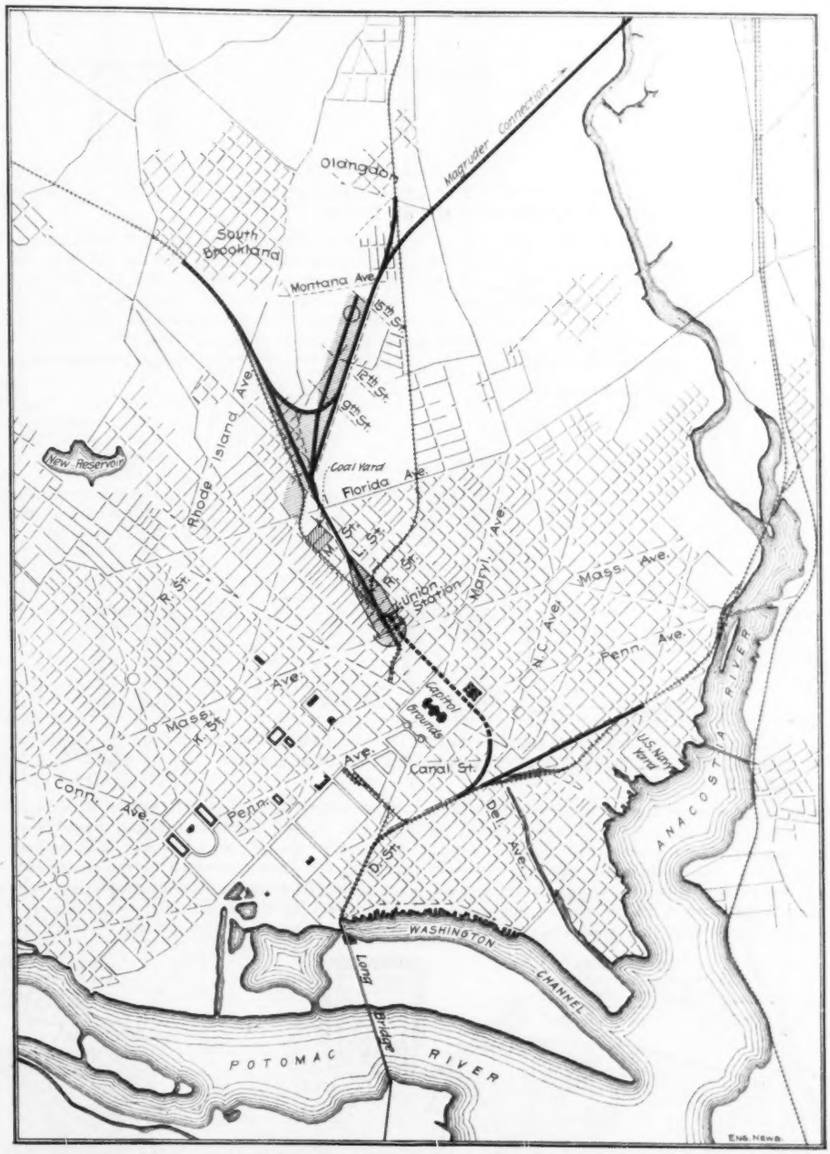


FIG. 1. SKETCH MAP OF UNION TERMINAL AT WASHINGTON, D. C., SHOWING LOCATION OF TUNNEL UNDER CAPITOL HILL.

The first operation as shown in Fig. 2 consists in driving two side drifts and a crown drift; the side drifts are 4½ ft. wide and 8 ft. high, and the crown drift is 6½ ft. wide and 8 ft. 8 ins. high. The timbering of all drifts consists of rectangular frames or bents of 10 × 10-in. timbers, back of which are driven 3-in. × 8-in. × 6-ft. poling boards. The material is removed from the heads of the drifts by small cars traveling on 20-in. gage tracks. For the crown drift the cars are of ½ cu. yd. capacity. Two miners and two helpers work in each drift excavating; one miner and one helper alternating with the other miner and helper so as to keep the work going under maximum pressure at all times. Three 8-hour shifts are worked daily, and about 10 ft. advance is made each 24 hours.

The succeeding set of operations consists of enlarging the crown drift laterally. As fast as the original drift is advanced, crown bars 12 ins. in smallest diameter and 24 ft. long are accurately placed and supported by posts sitting in the sills of the drift frame. This condition of the work is shown by Fig. 2. The next step is to drive poling boards over the crown bars and laterally into the sides of the drift. All but the roof timbers of the original drift timbering is then removed, and the drift is widened by breaking down both sides under the poling boards until a second pair of crown bars can be placed, as shown by Fig. 3. Poling boards are driven over this second pair of crown bars, and lateral excavation continued until a third pair of crown bars can be placed. In the same way succeeding crown bars are placed until the entire roof segment of earth has been

removed and the excavation timbered, as shown by Fig. 4.

The succeeding step is to replace the radial struts holding the crown bars with segmental arch ribs of timber serving the same purpose. To prepare for these arch ribs there are placed in the side drifts simultaneously with the roof excavation concrete footings. These footings are built about 3 ft. wide and 2 ft. thick, and so as to clear entirely the final sidewall masonry. On them are laid sills carrying vertical posts 8 ft. high, which carry 12 × 12-in. caps. Taking footing on these caps there are built arch ribs of 12 × 12-in. timbers in nine duplicate segments. These ribs are normally spaced 2½ ft. apart center to center, but in places where the pressure is unusually great the spacing is divided by two. When the timber ribs are complete the crown bars are wedged up from them, and the original radial strut supports are removed. The condition of the work at this time is shown by Fig. 5, and it will be noted that the entire core of material in the center of the tunnel is left clear of timbering. This core is removed by steam shovels, and the lining is constructed as shown by Fig. 6.

Simultaneously with the construction of the lining, excavation is begun for the right hand tunnel by excavating the crown and side drifts shown by Fig. 6. Care is taken not to advance these ahead of the finished lining. As shown by Fig. 6, crown bars are placed in the crown drift, and then this drift is enlarged laterally toward the right hand side drift and the lining on the left hand, as shown by Fig. 7. The next step is to replace the radial struts supporting the crown bars with timber arch ribs supported as shown by Fig. 8. Meanwhile the arch ribs over the left hand tunnel have been removed and replaced by radial struts from the lining to the crown bars as shown by Fig. 9, and work has begun backfilling the cavity over the left hand tunnel. The core shown by Fig. 9 is then excavated by steam shovel and the right hand lining placed, completing the tunnel except for the backfilling, as shown by Fig. 10. After the completion of the masonry in the left hand tunnel the crown bars are supported on the roof by short posts to guard against possibility of settlements when the timber arch is cut by the right hand tunnel. In the backfilling all the timber is left in the work except three segments of the arch ribs, the wall plates, posts and mud sills on the right side of the left-hand tunnel. These are within the area intersected by the right-hand tunnel and are recovered and used over. The original drift timbers are also recovered.

So far the methods of loosening the material and of removing the muck have been only briefly mentioned. In driving the drifts the material is excavated by pick and shovel in the usual manner and conveyed in small cars to the outside. The central cores are, however, removed almost entirely by steam shovels. The shovel used for this purpose is a Little Giant shovel operated by compressed air, and it takes out the core to a level about 1 ft. above sub-grade. In the larger core of the left hand tunnel there are about 23 cu. yds. per linear foot, and in the smaller core of the twin tunnel about 11 cu. yds. per linear foot. The shovel works one 10-hour shift at night and under favorable conditions will handle 500 cu. yds. per shift. It has a 1¼ cu. yd. dipper and loads into 3 cu. yd. dump cars, which are hauled in trains of three cars by electric mine locomotives. These locomotives take the cars out of the tunnel to the foot of a trestle incline leading over storage bins. A cable takes the cars up the

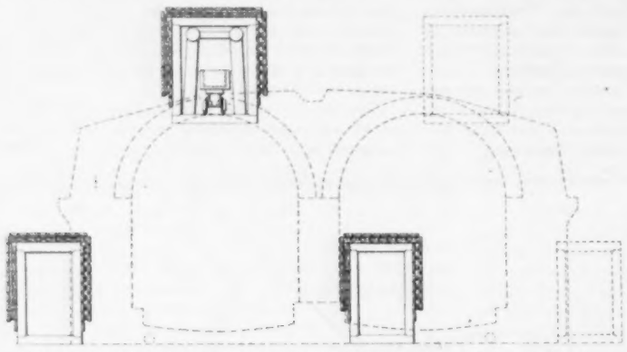


FIG. 2. SKETCH SHOWING DRIFTS FOR LEFT HAND TUNNEL. TWO BARS IN POSITION IN UPPER DRIFT.

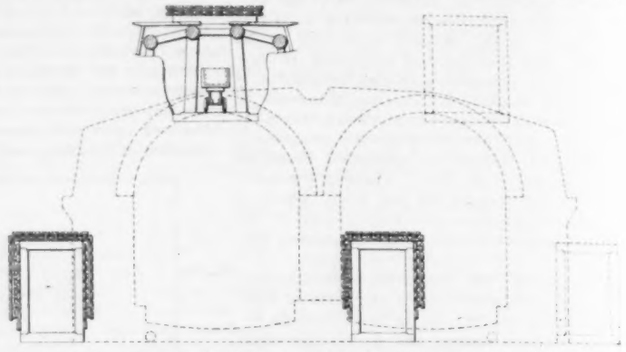


FIG. 3. SKETCH SHOWING SECOND BARS IN POSITION RIGHT AND LEFT.

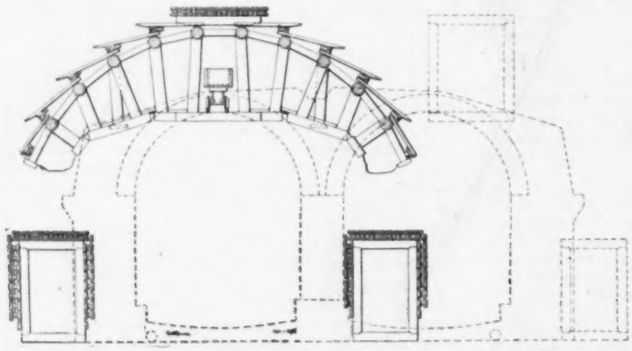


FIG. 4. SKETCH SHOWING ALL CROWN BARS IN POSITION AND GROUND IN READINESS TO SINK TRENCHES, TO PLACE WALL PLATES.

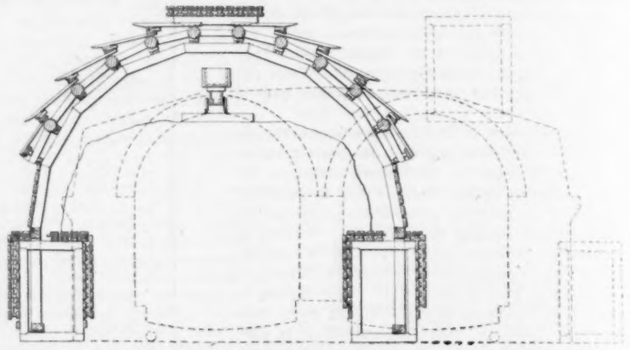


FIG. 5. SKETCH SHOWING CROWN BARS WEDGED ON SEGMENTAL TIMBER ARCHES; ALL PROPS REMOVED AND CORE READY FOR EXCAVATION.

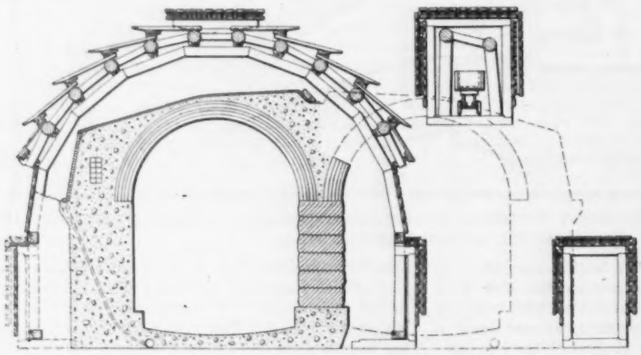


FIG. 6. SKETCH SHOWING MASONRY COMPLETED IN LEFT HAND SECTION—HEADING AND BOTTOM DRIFT COMPLETED IN RIGHT HAND SECTION.

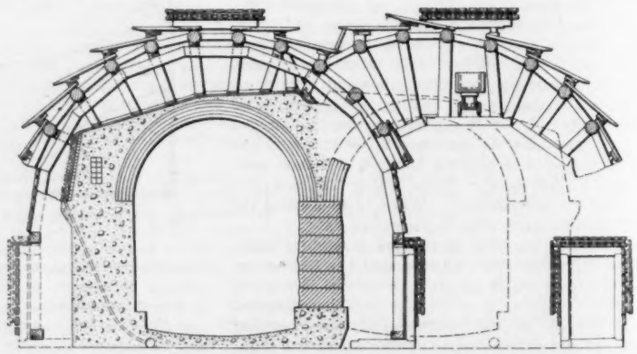


FIG. 7. SKETCH SHOWING CROWN BARS IN POSITION IN RIGHT HAND SECTION SUPPORTED BY PROPS IN CENTRAL CORE.

incline, where they are dumped into the bins. The bins are discharged through bottom gates into wagons, which take the material to places where it is being used for filling.

The provisions for draining the work are quite simple. In each bottom drift near the forward end there is a sump, from which a Snow pump operated by compressed air, forces the water through a long 3-in. pipe to a large sump located at the rear of the core excavation. From this main sump the water is removed by a centrifugal pump discharging through a 3-in. pipe, leading to outside the tunnel portal. The centrifugal pump is mounted on a timber platform with its operating motor, so that it can be easily shifted as the work progresses.

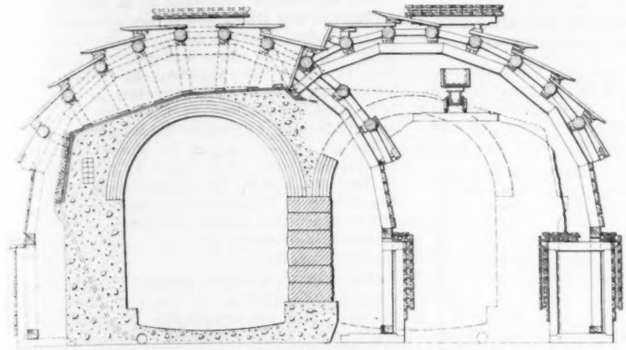


FIG. 8. SKETCH SHOWING SEGMENTAL ARCHES IN POSITION IN RIGHT HAND SECTION--PROPS REMOVED AND CROWN BARS WEDGED ON SEGMENTAL ARCHES.

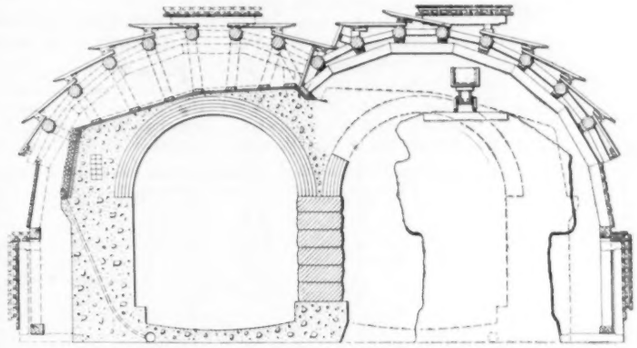


FIG. 9. SKETCH SHOWING SECTION OF LEFT SEGMENTAL ARCH REMOVED AND RIGHT HAND SECTION READY FOR EXCAVATION.

CONSTRUCTION OF LINING.—Three classes of work are required in constructing the masonry lining. Stone masonry work in the center wall, concrete deposited in mass for the side walls and brick arch construction for the roofs. Labor-saving appliances are used to an unusual extent in all of these classes of work.

In building the side and center walls use is made of a traveling derrick, details of which are shown in Fig. 11. This traveler moves ahead with the work on a 14-ft. gage truck, and it handles the stone and concrete buckets from the material cars to the workmen on the walls. In connection with the derrick in the concrete side wall construction use is made of steel plate forms for the inside faces of the walls. These forms are made up of 4 × 10 ft. sections of steel plate, constructed as shown by Fig. 12 and connected together by bolting the flanges together. The steel forms are erected by hand in advance of the derrick. In connection with the side wall work it should be noted that all concrete is machine mixed in a plant located outside the tunnel portal. Stone, sand and cement are brought to this plant, and once there they are handled, mixed and loaded into cars by mechanical means entirely. The cars are then taken into the tunnel by electric mine locomotives, and are unloaded by the traveling derricks. In a word, there is complete mechanical handling of the concrete from the time the component materials are delivered until it is tamped into the wall forms. With these derricks, about 15 ft. of side and center walls are completed in a 10-hour shift.

The derrick is operated about 100 ft. behind the steam shovel work and about 100 ft. behind it comes the roof arch construction. For this work use is made of a traveling center long enough to complete 20 ft. of roof arch. The construction of the traveling center is much similar to that of the traveling derrick, except that it is only 10 ft. high to the top of the platform and carries arch ribs for the centers instead of derricks, etc. The ribs of the center are set 4 ft. apart, and are wedged up from the traveler platform, so that they can be dropped by removing the wedges and the traveler moved ahead without taking down the centers. The lagging used on the arch ribs is 2½ × 4-in. stuff. The traveler is 20 ft. long, 16 ft. wide, and runs on the same 14 ft. track used by the traveling derrick. A 20-ft. section of arch is built in one 10-hour shift.

After each 20-ft. section of arch has been completed and before the centering is removed the concrete arch backing is placed and waterproofed, and the backfilling of earth is tamped in place. In performing these items of work use is made of the backfilling machine, shown in the drawings of Fig. 13. As will be seen, the device consists of a platform mounted on wheels, and of the same general construction as the platforms for the derrick and arch center previously described. On the front end of this platform is mounted a stationary hoist, and behind this is a belt conveyor platform. The latter structure is pivoted near the forward end, so that it can swing right and left on a circular truck under its rear end. It carries a 30 cu. ft. hopper on its forward end, from under which a belt conveyer ascends an incline toward the rear, and is carried back into the space behind the roof arch on a cantilever arm.

In operating the backfilling machine the material bucket is lifted from the car be-

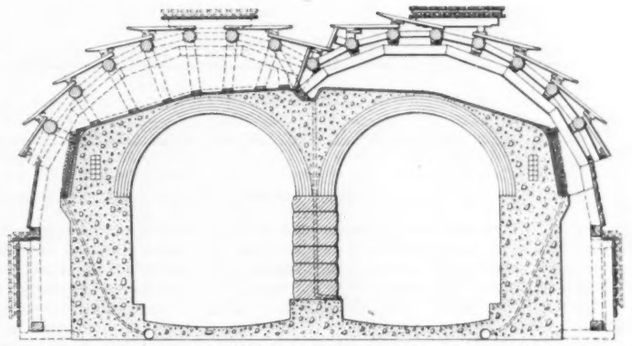


FIG. 10. SKETCH SHOWING MASONRY COMPLETED IN RIGHT HAND SECTION.

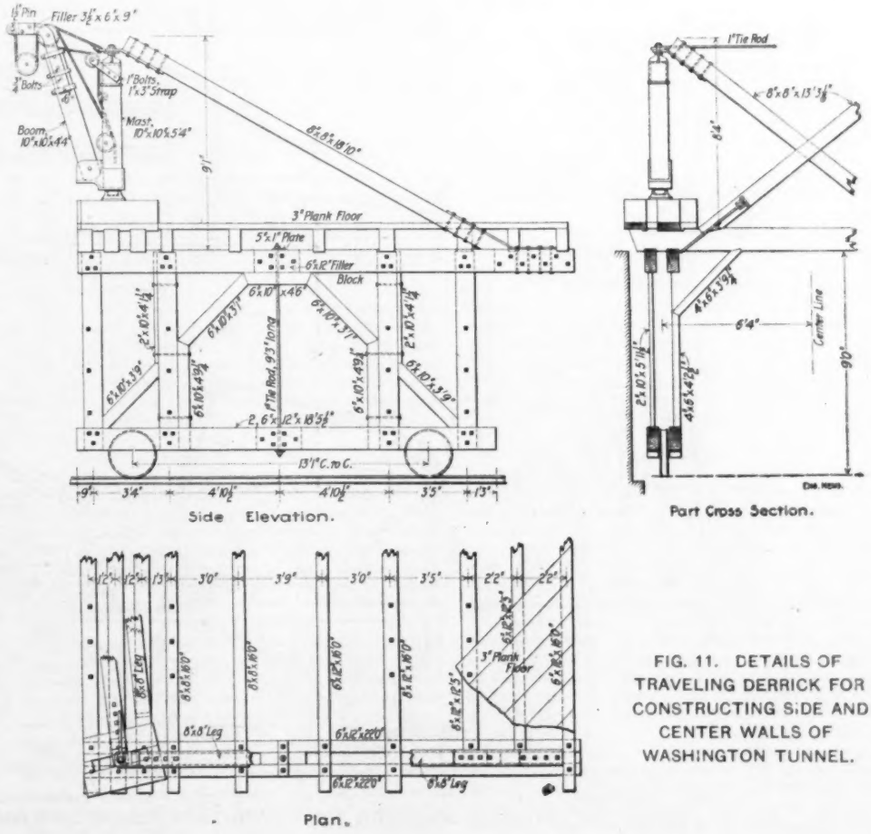


FIG. 11. DETAILS OF TRAVELING DERRICK FOR CONSTRUCTING SIDE AND CENTER WALLS OF WASHINGTON TUNNEL.

neath, carried back on the trolley beam until over the hopper, and there dumped by hand into the hopper. From the hopper the material falls onto the belt conveyer, and is carried back over the arch and dumped in place ready for tamping. It will be noted that the trolley beam of the hoist is so arranged that the hoisting movement is vertical until the bucket hits the trolley and is then up and backward until the stop at the rear end of the trolley beam is reached. This point is directly over the hopper. Hoisting is done by a Lambert engine, driven by a 15-HP. electric motor. The belt conveyer is 20 ins. wide, and is operated at a speed of 180 ft. per minute by a 7½-HP. electric motor. The apparatus requires two men to operate it, and is considered to save the labor of twelve shovelers. Both the concrete backing and the earth backfill are handled by the machine.

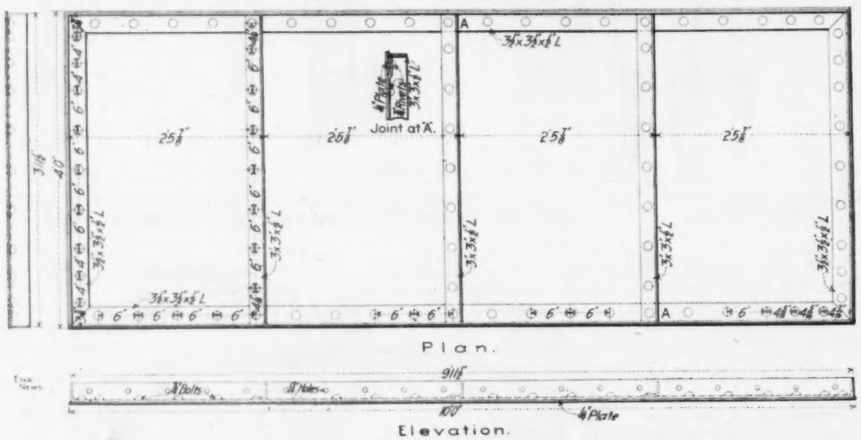


FIG. 12. DETAILS OF STEEL FORMS FOR SIDE WALLS OF WASHINGTON TUNNEL.

ENGINEERS AND CONTRACTORS.—The work described is being done under the direction of the engineering department of the Pennsylvania R. R., Mr. Wm. H. Brown, M. Am. Soc. C. E., Chief Engineer, and Mr. Robert Farnham, Jr., Assistant Engineer in Charge. The contractor is the New York Continental Jewell Filtration Co.; Mr. C. L. Parmlee, Consulting Engineer; and Mr. E. G. Williams, Resident Engineer and Superintendent.

THE MONTREAL CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.

There was held at Montreal last week the most important and successful meeting ever held by the above-named society. The members were hospitably and lavishly entertained by the Corporation of Montreal and both from the social point of view and with respect to the technical work done in the sessions, the convention fully satisfied those in attendance. The total number registered on the secretary's list was over 100.

In connection with the convention, an exhibition of municipal appliances was arranged for and a list of the exhibits is given in our Construction News Supplement. The exhibition was hardly a success, however, the number attending the convention being too small to repay the exhibitors for the expense involved in transporting and arranging their exhibits. As a result most of the exhibitors were firms located in Montreal and the exhibition was too meager and incomplete to attract much attention from the visitors.

The exhibition was held in a building known as the Crystal Rink, and it was attempted to hold the technical sessions in the same room; but defective acoustics and a deplorable tendency of the roof to admit the rain compelled the transfer of several sessions to the auditorium in the House of the Canadian Society of Civil Engineers, which was hospitably offered by that society.

The convention opened on Tuesday, noon, with formal addresses of welcome by the Mayor, Hon. H. Laporte, and by Mr. C. H. Catelli, on behalf of the Montreal Chamber of Commerce. Then followed the usual routine business, including particularly adding to the roll some eighty newly-elected members.

President A. Prescott Folwell then delivered an address in which he reviewed the history of the Society from its organization eleven years ago, with some sixty members. He frankly related the story how after the society's formation and a brief period of prosperity there came a time when its success seemed doubtful. In the years from 1897 to 1900 the membership decreased one-half and for the four years following, up to the convention held in St. Louis a year ago, it remained practically stationary. The necessity of taking hold and raising the society to a position of importance and influence or else letting it lapse into oblivion was forced upon the members, and as a result of the efforts of the last few months the membership has been increased to the highest point in its history. We quote further from President Folwell's address as follows:

As stated by our constitution, the object of this society is "to disseminate information and experience upon, and to promote the best methods to be employed in, the management of municipal departments and in the construction of municipal works."

The National Municipal League is largely composed of citizens as such, only, who consider "political, administrative and educational phases of the municipal problem." In the League of American Municipalities are gathered the mayors and other officials of our cities to study "all questions pertaining to municipal administration." The purpose of the American Civil Association is "the cul-

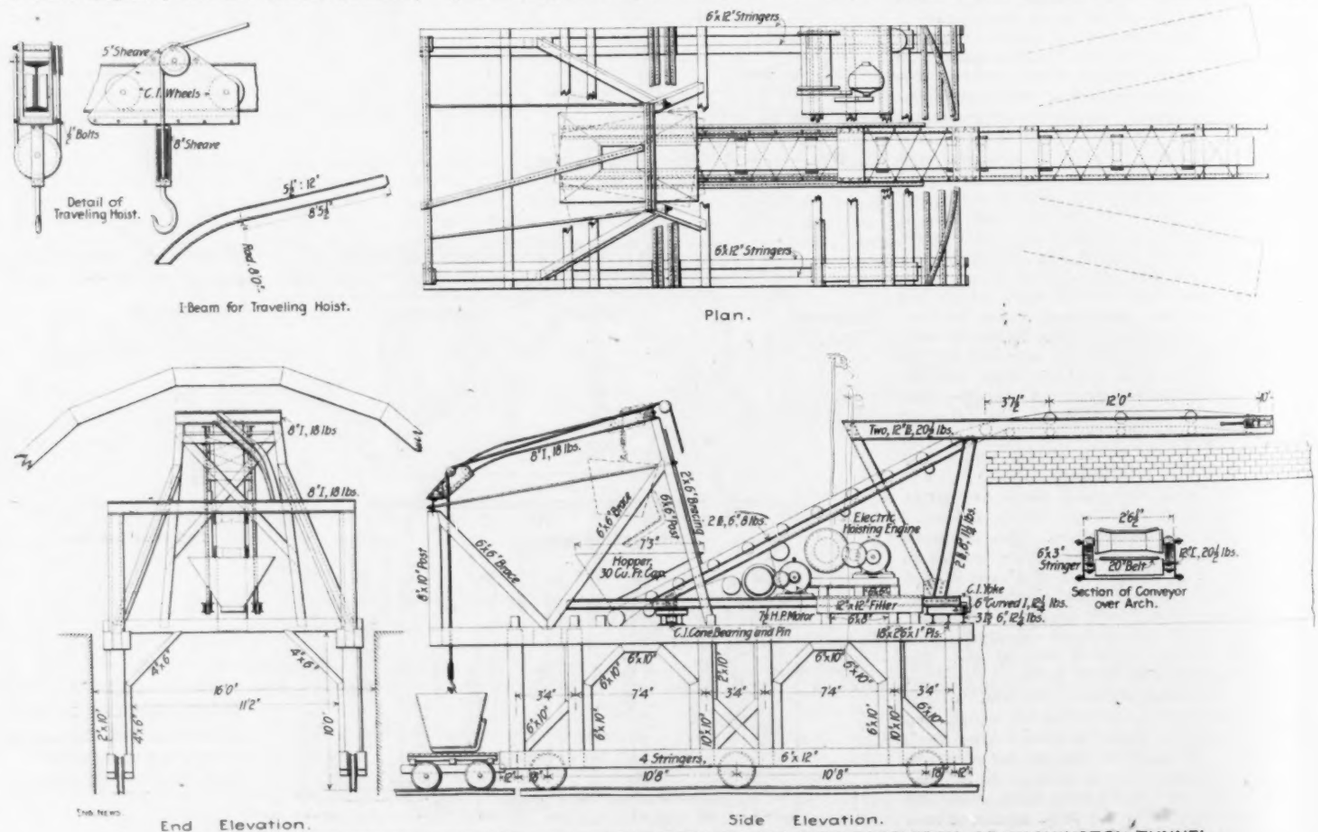


FIG. 13. DETAILS OF TRAVELING CONVEYOR FOR PLACING BACK FILLING OVER ROOF ARCH OF WASHINGTON TUNNEL.

tivation of higher ideals of civic life and beauty in America."

The first two consider chiefly municipal administration as a whole, and the methods of coordinating various municipal departments, but in only a minor degree the details of the management of individual departments; while the last would seem to be explicitly stated as one of the objects of this society, and one worthy of our earnest consideration.

At first thought it might seem that the field of engineering was already more than covered by existing societies. An examination of the work done by these, however, will show that this is not the case. The American Society of Civil Engineers and its Canadian sister, since they cover the entire field of engineering, pay very little attention to municipal engineering, as an inspection of their Proceedings will show. The various state and sectional societies do somewhat more along this line, but the amount is still relatively small and there is a tendency to continuance in local ruts. The municipal engineers of Greater New York have recently formed a society which has a most promising future, but its membership is limited to that corporation. There is a place, then, for a society which will do for all the other and smaller cities of the country what this last society does for New York; and many of the members even of that society have joined with us for mutual benefit along the line of municipal engineering. One branch of this, however—water supply—is well served by several societies, notably the American Water-Works Association and the New England Water-Works Association. But street paving, cleaning and general maintenance, refuse collection and disposal, sewerage and sanitation (except as the latter is treated from the physician's point of view by the American Public Health Association) and many other avenues for municipal improvement await the assistance of this society in their development.

The convention then took up the reports of the standing committees. The committee on municipal franchises reported through Mr. James Owen, of Montclair, N. J., its chairman, that all privileges and concessions for the use of public highways, whether for gas or water pipes, electric wires or car tracks, should be in the form of permits, revocable at definite periods, and that no legislation should be enacted which would prevent the municipality from ultimately controlling its own streets. A supplementary report was presented by another member of the committee, Mr. J. R. Barlow, City Engineer of Montreal, and discussion followed by Mr. Grossard, of Chicago, Mr. Hutchin, of Guelph, and others.

The session on Tuesday evening was chiefly taken up with matters relating to municipal legislation and government. A valuable paper by Mr. Nelson P. Lewis, of New York, discussed the theory of Assessments for Local Improvements, and related the method by which local assessments are conducted in Greater New York under its present charter. Mr. Milo R. Maltbie, Secretary of the Municipal Art Commission of New York, contributed a paper on the legislative control of New York City and made a plea for constitutional home rule. In the absence of the authors, the papers of Lewis and Maltbie were read by title only. Mr. Thos. J. Neville, Commissioner of Public Works of Rochester, N. Y., read a paper discribing the experience of that city under the so-called "White" charter. Mr. Neville stated that from Rochester's experience he doubted the possibility of a single charter proving satisfactory for the government of a considerable number of cities. Local peculiarities in different cities require special treatment, and frequent resort to the legislature for special amendments and enabling acts will be found necessary.

Mr. Frederick G. Todd, a landscape architect of Montreal, gave a paper illustrated by lantern slides on Park Design and a second illustrated paper was by Mr. Harry Brogg, on Canadian Cities.

An interesting review of municipal engineering progress, in Atlantic coast cities since 1880, by Mr. T. Chalkley Hatton, of Wilmington, Del., was read by title only. We are able, however, to present a brief abstract of the paper as follows:

Purification of public water supplies was scarcely thought of prior to 1880; but since that time over 150 water purification plants for public supplies have been built in the Atlantic coast states alone. The largest of these are the works at Philadelphia and Washington. The former has cost already about $22,500,000 and will require about $4,000,000 more to complete. Twenty years ago the average man looked upon typhoid fever as a punishment sent by Providence. Now even the most ignorant have the idea that they can ward off the disease by protecting themselves against an impure water supply.

Prior to 1880, sewerage systems were chiefly built for carrying off storm water. The writer knew of eight cities, one with over 300,000 population, which up to a few years ago, prohibited by municipal ordinance the discharge of house sewage in the sewers. Few sewerage systems in 1880 were planned as a whole system, but one storm sewer after another was built as immediate needs dictated.

Now a radical change has occurred. Sewers are now understood to be chiefly for sanitary purposes, and it is now the exception to find in the Atlantic coast states a city of 3,000 population or more without a sewerage system either completed or under way.

For the purification of sewage more than 80 plants have been built in Atlantic coast states since 1880. Chemical precipitation of sewage, once popular, has already disappeared and the process now in most favor is the septic tank, usually with subsequent filtration. There are now some 38 such plants under construction in the East.

While in the past sewage purification works have been chiefly built in the densely populated districts of New England, New York, Pennsylvania the states farther south are now turning attention to the pollution of water courses and urging measures for its prevention.

More money has been spent from city treasuries for paving since 1880 than for any other public purpose. The cost of pavements has decreased about 30% since 1890, although the cost of labor has materially increased. This result is due in the writer's opinion to smaller profits by the manufacturer, producer and paving contractor.

Street cleaning in even the larger cities prior to 1880 was more or less spasmodic and irregular; but with better paving has come systematic street cleaning.

In street lighting there has been a revolution with the introduction of the electric light. In 1880 the only street lights were dim gas or kerosene lamps. The young man or woman 20 years old can hardly conceive the change in conditions which these better lighting facilities has produced. A quarter century ago, it was rare for a woman to go out alone in any considerable town without an escort. Now city streets after dark are made almost as light as day and the chief recreations take place after night fall. Since 1890, moreover, there has been a great increase in the use of electric light, the demand being constantly for more brilliant illumination, as the following table will show:

City.	No. of arc street lights in— 1880.	1905.
A	1,125	3,731
B	195	2,800
C	50	989
D	94	811
E	587	1,906
F	149	329

The cost of electric lighting has decreased about 30% since 1890 and a further decrease is probable.

The development of underground conduits for wires instead of carrying them on poles has all taken place since 1890. The municipal electric conduit system of Baltimore is perhaps the best plant in the East.

More revolutionary than any other municipal improvement has been the change from the little slow moving horse car of 1880, seen then only in the larger cities, to the electric transportation systems of to-day. The latest transportation development in the larger cities is the underground electric subways of Boston, New York and Philadelphia.

In the sanitary disposal of garbage the progress has chiefly been an awakening to the need of better and more scientific methods of disposal for the mass of city refuse. The inventors who have sought to solve the problem seem to have generally labored in ignorance. About 90 disposal plants are now in operation in the Atlantic coast states but most of those visited by the writer seem far from perfect.

SOCIAL DAY.

The whole of Wednesday, Sept. 6, was devoted to various excursions, tendered to the guests through the courtesy of the city of Montreal. At 10 a. m. the visitors assembled at the City Hall and witnessed a fine exhibition drill by the Montreal Fire Department. They were then escorted through the City Council chambers and received by Mayor La Porte in his private office. Carriages were then entered and a long drive was taken through the most beautiful portions of the city and the places of greatest historic interest, the cavalcade finally halting on the summit of Mount Royal. After enjoying the unsurpassed view from this eminence, the guests were carried to the lawn adjoining the park conservatories, where under shelter of a great tent long tables had been spread. Informal speechmaking followed the luncheon, after which the carriages were again taken and the visitors were finally left at Place d'Armes Square. After visiting such points of interest as the celebrated Notre Dame cathedral and the Bank of Montreal, the visitors boarded special electric cars and were carried westward through several suburban towns to Lachine. Here a steamer was taken for the famous trip down the Lachine Rapids, a journey which notwithstanding the number of times it has been safely accomplished, is, to an engineer familiar with the possible accidents to propelling and steering machinery, fraught with sufficient spice of danger to make it exciting.

An evening session at the House of the Canadian Society of Civil Engineers followed the day's excursion. The first matter taken up was a series of excellent papers on Street Paving. Mr. Clarence D. Pollock, of Brooklyn, N. Y., Chairman of the Paving Committee, read a paper contributed by Mr. W. J. Stewart, of Rochester, on Gutters and Cross Walks for Macadam Pavements. In Rochester these were formerly of stone on sand or (later) concrete foundation; the crossings are of cut stone flags 18 ins. wide with joints cut diagonal. There are three courses of flagstone 6 ins. apart, a course of flagstone filling this space and 3 ft. of paving on either side the flagging, making a crossing 11½ ft. wide. This, while satisfactory, is very expensive, and a more recent construction employs brick blocks on 4 to 6 ins. of concrete, thoroughly grouted. This is much cheaper and equally satisfactory. In the gutters Mr. Stewart prefers to lay brick at an angle or better herring-bone fashion, as it makes a better joint with the macadam.

A paper on the use of oil on macadam roads in California, by Theodore F. White, of Los Angeles, led to an interesting discussion over the use of oil in the East. Secretary Tillson stated that for a recent automobile race in Long Island the roadway was oiled with very satisfactory results. The course was about two miles long and 1,000 to 3,000 gallons of oil per mile was used, making the cost, at 7 cts. per gallon, $70 to $210 per mile. For good results, the road should be covered with at least an inch of dry dust when the oil is applied. Mr. Rust, of Toronto, had tried oil on a suburban street. While it laid the dust, it tracked in to houses and was so objectionable that its use was abandoned. Mr. J. W. Howard said that in the dry climate of southern California where the dust is a nuisance impossible to conceive of here, oiled roads are a great blessing. Only the Texas or California oils, which have an asphalt base, should be used. In no place can oil be used on city streets and in a humid climate its success anywhere is very doubtful. It was tried at Belmar, N. J., and on the first rain the oily dust formed an emulsion with the water and the road was as if covered with wet meal, which stuck to and spoiled everything with which it came in contact. He advised his clients who desired to improve macadam roads to stay by the old method of applying soft coal tar, hot.

Mr. Hazelhurst, of Mobile, Ala., had considered the use of Beaumont oil for the dusty oyster shell roads of his city; but had concluded that with the heavy rainfall of 60 inches per year the oil would be unsuccessful.

Mr. Barrow, of Montreal, said that he had improved some old macadam pavements at very small cost by taking old asphalt, cooking it over and spreading it on top of the old macadam.

A paper by Mr. E. J. Frost, of Brooklyn, describing the street repair system of that city, was read by title, and the convention then listened to a bright, chatty paper by Mr. J. W. Howard, of New York City, on the importance of preliminary tests of paving materials. He declared that the cheapest pavement was the one which was cheapest to keep in repair regardless of its first cost. Paving is not a new art. The still existing pavements laid by the Romans show the importance of good foundations to secure durability.

Among the more recent successful pavements is brick. There are now about 168 paving brick plants in the United States, of which a few produce good brick and many poor ones. Tar macadam paving was first used in Germany, in a few

English towns, in Canadian cities and a very little in the United States. The experiments were not satisfactory, but enough success was obtained to show that coal-tar products might be used if definite materials, mixtures and methods could be established. The legitimate outcome of this was the successful introduction five years ago of what is known as the bitulithic pavement.

The remainder of Mr. Howard's paper was chiefly devoted to an outline of the various tests proper for each class of paving materials.

Mr. Eggers, of Newark, asked for records of experience with bitulithic pavement. In response Mr. Carpenter, of Pawtucket, where the first bitulithic pavement was laid, said this piece of pavement is now entering on its fifth year. It has had no repairs in that time, and he could not see that it is any different from the day it was laid. He considered the pavement entirely satisfactory, and the city laid 20,000 sq. yds. additional last year. Mr. Carpenter finds that in laying bitulithic along street rails there is no necessity of putting a course of stone or brick next the rail as with asphalt. Mr. Julian Kendrick said that 100,000 sq. yds. of bitulithic had been laid in Birmingham, Ala. It is used on some steep grades and has proved very satisfactory. Mr. Rust said that Toronto has 50,000 sq. yds. of bitulithic pavement. It is not as slippery as asphalt or as noisy. It costs about $2.25 per sq. yd. with a ten-year guarantee.

Garbage disposal was the next subject taken up, papers being read by Mr. B. E. Briggs, City Engineer of Erie, Pa., and Mr. Howard G. Bayles, of New York City.

Mr. Briggs gave some figures, however, which may be summarized as follows:

City.	Cost per ton of collection and disposal.	Lbs. per head of population per annum.	Cost per head of population per annum.
Buffalo	$2.19	172	19 cts.
Atlantic City	1.14	...	...
Milwaukee	3.26	248	40 cts.
St. Louis	2.80	160	23 cts.
Salt Lake City	2.60	133	17 cts.
Terre Haute	1.86	158	15 cts.
Chicago*	.86	912	39 cts.

*Includes street sweepings.

Mr. Bayles' paper gave the cost of garbage collection and disposal in Cleveland, Milwaukee and Muncie, Ind., Atlantic City, N. J., and Bridgeport, Conn., all of which plants he roundly condemned. The remainder of the paper was devoted to a description of the Decarie incinerator as installed at Minneapolis and Atlanta. At Minneapolis, Mr. Bayles said that in 1904 there were 19,079 tons of refuse collected and the costs chargeable against the disposal plant were $7,370. The cost of incineration per ton of mixed refuse was 38.6 cts. A similar furnace is to be erected by Minneapolis at the opposite end of the city next year.

The Decarie plant at Atlanta has a capacity of 200 tons per 24 hours and is an improvement on the one at Minneapolis. No fuel is used in the furnace except during the melon season, and the cost of operation when no fuel is used has thus far averaged about 14 cts. per ton. The repair item is negligible. Atlanta will duplicate this incinerator in another part of the city within a year. Mr. Bayles believed this Atlanta plant was superior to the English type of refuse destructors. In conclusion, he condemned the practice of picking refuse for the recovery of glass, metal, etc., as unsanitary, and declared that the tuberculosis and other contagious diseases thus disseminated cost the country far more than the whole value of the material recovered.

In the brief discussion which followed these papers it was stated that Westmount, a suburb of Montreal, is just about installing an English destructor.

The Report of the Committee on Electric Street Lighting was read by Mr. Edwin A. Fisher, City Engineer of Rochester. He advised the use of enclosed arc lamps, and said that the alternating current appears to be taking the lead for street lighting. Some difficulty was at first experienced with interference between telephone circuits and high tension alternating circuits, but it has been overcome.

The size of lamp most generally used is that of 2,000 normal c.-p., or 450 watt lamp, but Mr. Fisher thought that in any new installation the question of smaller units should be considered. The distance apart of 450 watt lamps may vary from 450 to 500 ft. in fairly built-up sections to 100 to 200 ft. in business districts, and in unsettled sections 600 to 800 ft. may be used. In conclusion, Mr. Fisher indicated that either state control and supervision of electric lighting monopolies or else municipal ownership must be generally adopted in the near future.

The evening session closed with the selection of Birmingham, Ala., as the place for holding the convention of 1906 and the report by the Nominating Committee of the following officers for the year ensuing:

President, C. C. Brown, of Indianapolis; First Vice-President, John R. Barlow, of Montreal; Second Vice-President, Jas. Owen, Montclair, N. J.; Third Vice-President, Julian Kendrick, Birmingham, Ala.; Secretary, G. W. Tillson, Brooklyn, N. Y.; Treasurer, F. J. O'Brien, Oswego, N. Y. All these nominees were duly elected.

On Thursday morning the session was devoted to papers by city officials of Montreal, opening with a most interesting and scholarly paper by Hon. R. S. Weir, Judge of the Recorder's Court of Montreal, relating interesting anecdotes of the city's history and reviewing its present condition. The municipal asphalt plant of Montreal was described by Mr. Barlow, City Surveyor, in a paper which we shall shortly reprint. The city's fire alarm system was described by Mr. Jas. Ferns, its Superintendent; and Alcide Chausse, Chief of the Bureau of Buildings, contributed an excellent paper on building laws.

Thursday afternoon was spent on an excursion, on a special train furnished through the courtesy of the Canadian Pacific Ry., to the great new Angus locomotive and car shops of that company in the suburb of Hochelaga.

The closing session of the convention was held on Thursday evening, and opened with a paper on the purification of water by copper sulphate, contributed by Daniel D. Jackson, of Brooklyn. Mr. Jackson has used copper sulphate extensively for the treatment of algae in the Brooklyn water supply and has had excellent success. In general, where the nature of the organism is not known, 1 part of the copper sulphate to 2,000,000 parts of water is sufficient; but some of the more sensitive organisms succumb to much smaller amounts, uroglena, for example, yielding to 1 part in 20,000,000.

A rise in water bacteria is apt to follow the use of copper, the bacteria feeding on the dead algae.

Experiments by Mr. Jackson show that the bacillus coli communis and the typhoid bacillus of the attenuation usually found in water are both destroyed by copper sulphate of 1-2 [illegible] strength. Fresh virulent typhoid germs when added to water, however, require as much as 1 part to 50,000. Such a strong solution is not to be recommended for drinking water; but the treatment of contaminated waters with 1 to 1,000,000 copper sulphate will greatly reduce the danger although not giving complete protection.

Mr. E. S. Rankin, Engineer of the Newark Sewer Department, presented an admirable review of the anti-mosquito campaign and the results accomplished to the present time. In the discussion, Mr. Hazelhurst gave an interesting account of the active campaign against mosquitoes which has been carried out by the city of Mobile in the endeavor—which has thus far been successful—to ward off the yellow fever with which many of its neighboring cities are now stricken.

A paper by Mr. Wm. S. Crandall advocating a Government standard for disinfectants was next on the program, and then followed a paper by Mr. Hazelhurst describing the sewerage system of New Orleans, La., and the difficulties met with by the engineer and contractor in the South on account of the unreliability of negro labor.

Mr. W. H. V. Reimer, City Engineer of East Orange, N. J., read an interesting account of the chemical sewage disposal plant at East Orange, which was built 18 years ago, but which was abandoned as a failure after a few years' operation. The cause of the failure, in Mr. Reimer's opinion, was chiefly the large amount of ground water admitted to the sewers, which from the beginning taxed the plant beyond its capacity.

On Friday morning a number of the members remained for an excursion about the harbor, tendered by the Montreal Harbor Commission, but most of the visitors departed on early trains.

THE 1,800 FT. SPAN CANTILEVER BRIDGE ACROSS THE ST. LAWRENCE RIVER AT QUEBEC.

Construction work on the Quebec Bridge has reached a point where we are able, through the courtesy of the builders, to give some interesting items regarding the cantilever portion of the structure. A brief statement of the character the main dimensions of this bridge was published in our issue of Nov. 20, 1902, while in our issue of Jan. 29, 1903, the piers and foundations were described in detail.

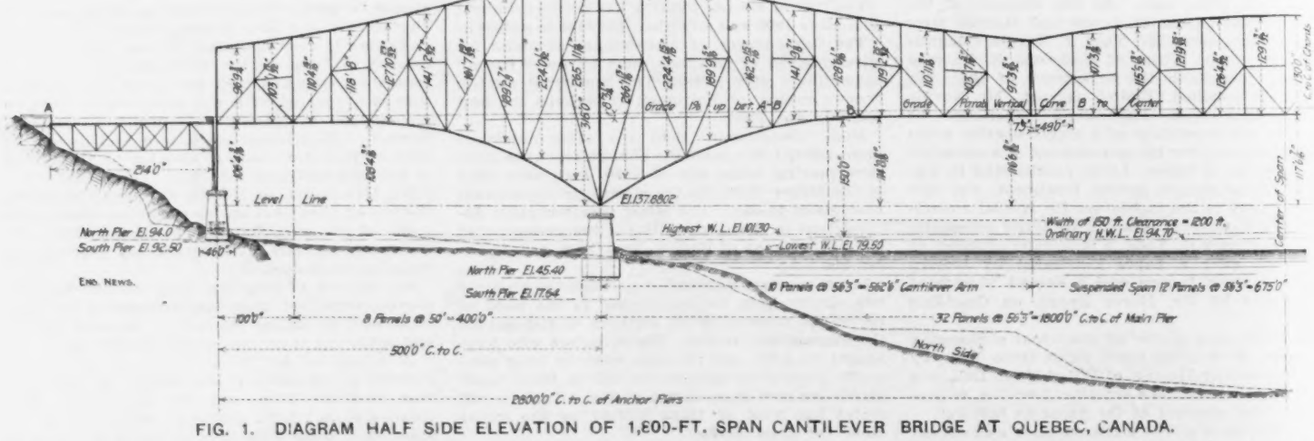

Level Line
El 137.6802
Highest W. L. El 101.30
Lowest W. L. El 79.50
North Pier El 94.0
South Pier El 92.50
North Pier El 45.40
South Pier El 17.64
Width of 150 ft. Clearance = 1200 ft.
Ordinary H.W.L. El 94.70
10 Panels @ 59'3" = 592'6" Cantilever Arm
Suspended Span 12 Panels @ 59'3" = 675'0"
32 Panels @ 59'3" = 1800'0" C. to C. of Main Pier
8 Panels @ 50' = 400'0"
100'0"
500'0" C. to C.
North Side
2600'0" C. to C. of Anchor Piers
460'
214'0"

FIG. 1. DIAGRAM HALF SIDE ELEVATION OF 1,800-FT. SPAN CANTILEVER BRIDGE AT QUEBEC, CANADA.

As many of our readers are aware, this bridge has a river span of 1,800 ft., which is the longest bridge span of any type in the world; the main cantilever spans of the Forth Bridge in Scotland are only 1,710 ft. and the river span of the Williamsburg suspension bridge at New York city is only 1,600 ft. The bridge is being constructed for the Quebec Bridge & Railway Co.. Hon. S. N. Parent is President, Mr. E. A. Hoare, Chief En-

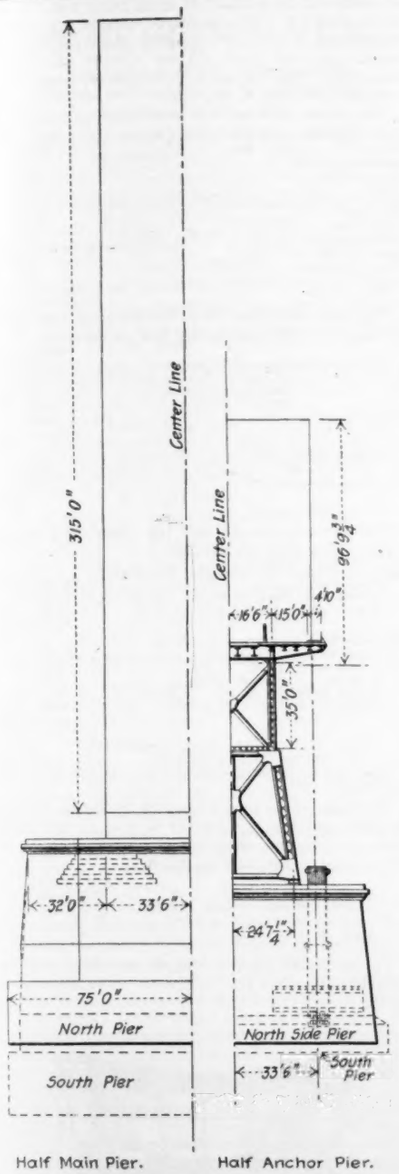


Fig. 2. Transverse Sectional Elevations of Quebec Bridge, Showing Main and Anchor Piers.

gineer, and Mr. Theodore Cooper, M. Am. Soc. C. E., Consulting Engineer of the company. The contractor for the superstructure and erection is the Phoenix Bridge Co., of Phoenixville, Pa. We are indebted to Mr. John Sterling Deans, M. Am. Soc. C. E., Chief Engineer, Phoenix Bridge Co., for the information from which this account of the work has been prepared.

LOCATION.—The bridge is located over the St. Lawrence River about six miles above Quebec, Canada, and about 165 miles below the City of Montreal, and some 800 miles from the sea. There is no bridge over the St. Lawrence between Montreal and Quebec, nor is there any suitable location for a bridge structure below the city of Quebec, as the St. Lawrence widens out to such an extent as to make it practically impossible to bridge the river below that city. The structure now building at Quebec will, therefore, be the only crossing of the river for a distance of about 1,000 miles, and will be the only means within that distance of crossing the river by railroad and highway traffic.

The bridge, upon its completion, will make it possible to transfer business between the Great Northern Railway of Canada, The Quebec & Lake St. John R. R. and the Canadian Pacific R. R. on the north side of the river, and the Grand Trunk R. R., Intercolonial R. R. and the Quebec Central Ry. on the south side of the river. The bridge is also located on the new Grand Trunk Pacific Transcontinental line

GENERAL DESCRIPTION.—The bridge proper consists of two 210-ft. pin connected deck approach spans; two 500-ft. anchor spans, and one 1,800-ft. central span. It is designed, as shown by Fig. 2, to carry two lines of railway, two trolley lines, two highways and two sidewalks. The sidewalks are carried on the outside of the trusses, the balance of the traffic is carried between the trusses. The trusses are placed 67 ft. apart c. to c. The clear headway above highest tide is 150 ft.

The main bridge is of pin-connected cantilever design. The eyebars are in general 15 ins. and 16 ins. in width, and for a few special details they will probably be 18 ins. in width. In general the pins are 12 ins. in diameter, the main lower pin at shoe, however, being 24 ins. in diameter. The main chords are 54 ins. in depth and 68 ins. in width. The main post over river pier is 10 ft. in width by 4 ft. deep. The main intermediate posts are from 40 ins. to 48 ins. in width. The main plate floor beams are 10 ft. deep. The suspended span is 675 ft. long and 130 ft. deep at the center.

The general outline of the main span, giving the heights at the various panel points and other information, is shown by Fig. 1.

The great size of the sections and details, indicated above, is further exemplified by the assembled shoes and pedestals of the main truss post, which are shown in Fig. 3. As will be seen, this detail is of built up wrought steel; no castings are used in the entire construction. The weight represented by the connection as shown in Fig. 3 is about as follows:

	Lbs.
Upper pedestal	95,000
Tower pedestal	155,000
Shoe	148,000
Center chord	102,000
Main post shoe	57,000
Total	557,000

The pedestals and main shoe combined weigh, therefore, about 199 tons, of which 78 tons are contributed by the main shoe.

ERECTION.—The falsework under the anchor arm, Fig. 4, consists of two main parts. The central portion of the falsework is made of wood, upon which the floor of the bridge is supported, and on which the materials are delivered to the traveler. The outer portion of the falsework is of steel, in groups of four columns at each panel point, thoroughly braced in all directions, and at the top of each group having a metal platform to receive the lower chords of the bridge. In addition this outer steel falsework carries the metal girders upon which the steel traveler, Fig. 5, runs, this steel traveler being what is known as an outside traveler, enveloping the entire structure. The traveler is served by four electric hoists (two drums and four winches in each hoist), and is designed to handle readily the heaviest pieces of 105 tons. The traveler has a base of 100 ft. and is 215 ft. high, with an over-reach of 66 ft. For the erection of the cantilever and suspended span the traveler is supported upon steel bents resting on temporary box girders, supported at panel points from the main pins of the bridge.

The material is received from the shops at Phoenixville, Pa., in a storage yard, near the end of the bridge. This storage yard is about 750 ft. long and is served by two 70-ft. electric cranes.

FIG. 3. VIEW OF PEDESTALS AND SHOES, WITH MAIN POST AND DIAGONALS CONNECTED. QUEBEC BRIDGE.

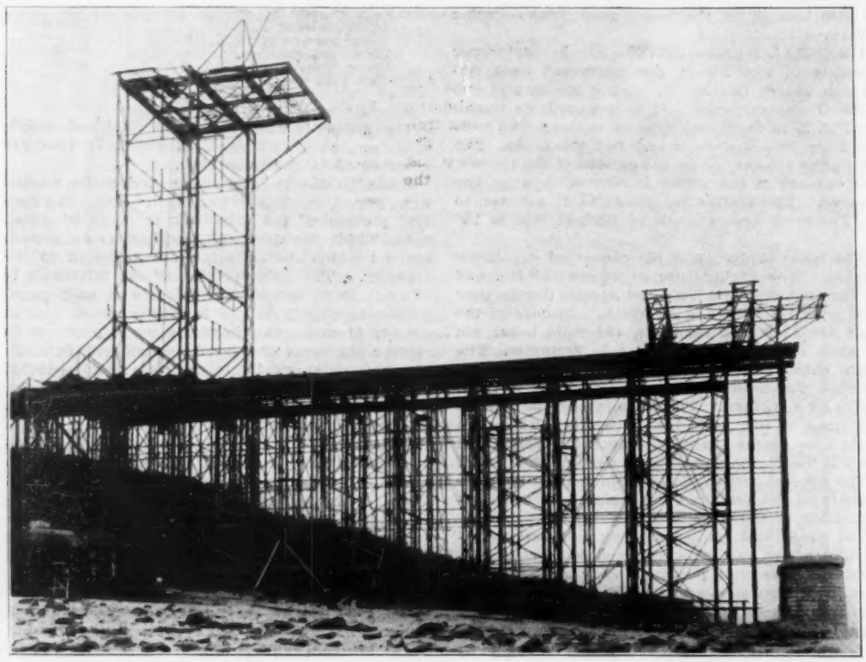


FIG. 4. FALSEWORKS AND TRAVELER FOR ERECTING SHORE CANTILEVER ARM OF QUEBEC BRIDGE.

From the storage yard the material is run on cars at grade directly to the bridge underneath the main traveler.

PROGRESS.—Immediately upon the completion of the railway approach, during July, 1905, the rigging of the main traveler was completed and the actual erection of the permanent metal was begun on July 22d. On Sept. 1, 1905, the main anchorage bent on the south side of the bridge, all the lower chords and bracing of the south anchor arm, the main pedestals, the shoes, etc., over the main pier, were in place; the erection of truss web members will be started at the anchorage end early in September. The work of erection will have to be suspended during the winter months, probably from about Nov. 15 to April 15.

THE FAILURE OF TWO RESERVOIR DAMS BY FLOOD AT SHERBURNE, N. Y.

By E. F. Musson.*

The vicinity of Norwich, N. Y., was visited by a very severe rain storm Sunday evening, Sept. 3, which did great damage to highways and took off nearly all the smaller bridges in the towns of New Berlin, Sherburne, North Norwich and Columbus.

At Sherburne the storm did great damage to the water-works. The village is supplied by gravity from two reservoirs with capacities of 20,000,000 and 10,000,000 gallons, respectively. The smaller and lower reservoir was built in 1883 and the other, immediately above it, in 1892. The drainage area is small but very hilly. The dam was about 300 ft. long and 34 ft. high, built of earth with a puddle core wall. It had a spillway 30 ft. wide at the bottom and 5 ft. deep. The overflow passed the lower reservoir in an artificial channel and discharged by the side of the spillway of the lower reservoir, a wall dividing the channel and the spillway.

The upper dam was overtopped by the flood. About one-half of it was entirely washed out and about one-third of the lower side of the remaining portion was also carried away for its entire length. The water thus set free passed to the lower reservoir and carried away the partition between the two spillways, thus caring for a large part of the flood. But the water still rose until it was about 2 ft. above the top of the second embankment, the lower part of which was then washed out back as far as the puddle for a distance of 60 ft. Fortunately the water receded so that the embankment was not carried entirely away. The pipe line was also broken and about 200 ft. washed away.

The stream below the reservoir passes through a deep gorge, so that no damage was done except to carry off a bridge. At the village below but little damage resulted except the flooding of a few cellars and washing out a few lawns.

*Engineer and Surveyor, Norwich, N. Y.

COST OF LAYING WATER PIPE, ATLANTIC CITY, N. J.

By Kenneth Allen,* M. Am. Soc. C. E.

Some very complete figures on the cost of laying 1½ miles of 6-in. cast iron water pipe at an unnamed place were contributed to your columns by Mr. E. W. Cowan not long ago (see Engineering News, Dec. 1, 1904). It is a pity that more such figures are not made public, and as a contribution to that end some cost figures are here given for about three miles of 12 to 4-in. pipe, recently laid by the Water Department of Atlantic City, N. J. Although accurate figures of cost were kept throughout the work there were so many complications at some points as to greatly increase the cost of the larger mains, and thus render the details of their cost of little value. The complications arose (1) at street crossings, where there was not only a duplicate system of water-mains but also conduits for two telephone companies and for a refrigerating company, besides hot-water, gas and sewer pipes, nearly all within 4 ft. of the surface, and (2) along stretches of the new water main where on one side an old 6-in. water main extended for 7,623 ft. and on the other an 8-in. gas main for 4,121 ft. Both these pipe lines had to be maintained and the old water main had to be removed.

The 16,085 ft. of new pipe was divided by sizes as follows: 12-in., 3,621.5 ft.; 10-in., 3,202 ft.; 8-in., 4,287 ft.; 4-in., 4,975 ft.

Table I. includes such details of the cost of the 12, 10 and 8-in. pipe as, in view of the circumstances just named, it seems worth while to give.

TABLE I.—Cost of Material and Labor for 12, 10 and 8-in. Water Pipe.

Size, ins.	12	10	8
Total length, ft.	3,621.5	3,202	4,287
Pipe, lbs. per ft.	84.3	68.7	46.5
Cost, per ft., cts.	96.57	76.23	51.10
Lead: lbs. per ft.	2.77*	2.04	1.04
Cost, per ft., cts.	12.33*	9.79	5.40
Jute: cost per ft. at 5½c. per lb., cts.	0.433	0.46	0.23
Total material, including freight, haul of pipe, valves, boxes, etc.	$1.37½	$1.03	$0.80½
Total labor	.79	.56	.29
Total, inclusive of lumber, fuel and tools	$2.16½	$1.59	$1.09½

*Approximate.

In the case of the 4-in. pipe there was but little interference on account of other pipes and the results may be taken as fairly reliable for similar conditions. The trench was about 40 ins. in depth, in sand that did not require shoring or pumping. The figures include one crossing under a double-track street railway.

The prices paid on this work were as follows:

4-in. pipe weighing 230 lbs. per length	$22.20*
6-in. " " 380 " " "	22.50*
Special castings	50.00*
4-in. valves	6.25
6-in. "	10.25
12 × 4-in. Smith connection (sleeve and valve)	23.00
8 × 4-in. " " " "	18.00
Valve boxes	3.10
Lead, per lb.	.04
Jute, per lb.	.05
Haul, per ton	.75

*Per net ton.

The cost per lineal foot, exclusive of fuel, haul of lead and jute and tools, was as follows:

		Cents.
Material:	Pipe, 19.66 lbs.	21.59
	Specials	1.09
	Valves and boxes	6.25
	Lead, 0.45 lbs.	2.22
	Jute	0.13
		31.28
Haul		0.84
Trenching, etc.		6.20
Pipe laying		5.05
Superintendence		1.25
		12.50
Total		45.19

The force employed and the wages per day of eight hours were as follows:

For trenching, backfilling and watchman:	
1 foreman ½ day, at $2	$1.00
8 men, 10¼ days, at $1.50	15.38
1 watchman, 1 1-16 day, at $1.50	1.75
	$18.13
For pipe laying:	
1 foreman, ½ day, at $2	$1.00
1 lead man, 1 day, at $2	2.00
2 calkers, 1 day, at $2.50	5.00
4 pipe handlers, ¾ day, at $1.75	5.25
1 pipe handler, ¼ day, at $2	1.50
	$14.75
Total cost per day (approximately)	$32.88
Feet laid per day, average	292

Coke used for melting lead, 28.2 lbs. per 100 ft. of pipe, costing 8.46 cts.

The cost of setting hydrants, based on setting 10 4-in. and 1 6-in. hydrant in 3 ft. of dry sand, with an average of 5 ft. of pipe connection to valve already set, was as follows:

	Per hydrant.
Time	3.2 hours.
Average number of men employed	7.5
Cost of material and haul	$3.26
Cost of labor	4.46
	$7.72

To the total named should be added cost of superintendence. The hydrants were already in stock.

*Engineer and Superintendent of Water Department, Atlantic City, N. J.

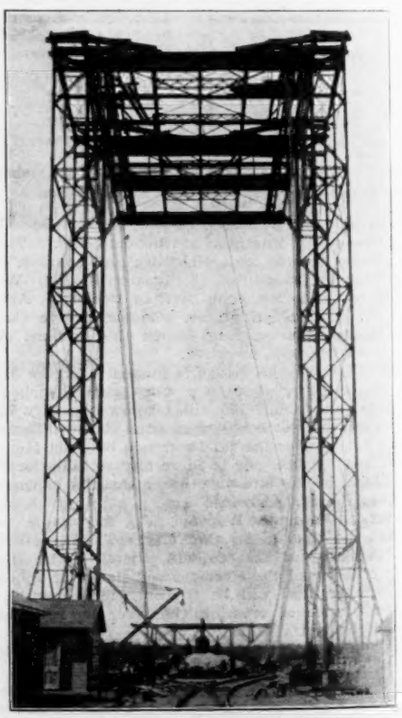


Fig. 5. View of Erection Traveler from Rear, Quebec Bridge.

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We have great pleasure in laying before our readers this week a series of biographies covering the professional record of the distinguished engineers composing the Advisory Board for the Panama Canal. This body of engineers has been brought together to render an opinion on what is doubtless, measured by the dollars and cents standard, the most stupendous engineering problem ever presented. The engineers in the United States, who are by experience, character and reputation, of the caliber fit for membership on such a Board are by no means numerous. We emphasize particularly the experience, for most American engineers who have acquired large reputations have done so either in the field of railway engineering or bridge engineering. The great hydraulic engineers of this country have been chiefly experienced in the work of municipal water supply. Of actual work in ship canal construction and operation there has been practically none in this country save that on the great canal and locks at Sault Ste Marie. Even in the work of dock and wharf and harbor construction, which is the field of engineering closest allied to works necessary for a ship canal, American engineers have carried out few works of great magnitude, with the exception of some of the works created by the Corps of Engineers of the Army.

Under these circumstances it was eminently wise to make the Advisory Board an international one and seek the opinions of the great hydraulic engineers of England and France and Germany in co-operation with the leaders of the profession in the United States. The deliberations and conclusions of this Board must have added weight the world over, by reason of its international character. It may be added further that good precedent exists for seeking the advice of an international body of engineers for a work intended to benefit the commerce of all nations. The Suez Canal, although originally a French enterprise, was carried out with the aid of engineers of other nationalities; and in the days when France controlled the Panama enterprise, an international congress and later a selected international engineering commission were brought together to advise concerning the great work.

While it is to be assumed that all the members of the Board will approach the problems submitted to them with a judicial mind, it is not without interest to note that Messrs. Parsons and Burr as members of the old Commission went on record as favoring a sea level canal, while Gen. Abbot as a former member of the International Commission which planned a lock canal for Panama may be supposed to incline toward that plan. The Chairman of the Board, Gen. Davis, from his past experience as General Manager of the Nicaragua enterprise, is doubtless not opposed to a lock canal. The same may be said of Mr. Alfred Noble, too, as one of the authors of the plan of the Panama Canal Commission of 1900, which involved the use of locks.

Mr. Ripley, by long service at Sault Ste Marie, is entirely familiar with the working of one of the great ship locks of the world and the one which doubtless has far more active use than any other in existence. The distinguished foreign engineers are also thoroughly familiar with the actual construction and working of marine locks of large size. From all appearances, therefore, the great question whether the Panama Canal shall be built at sea level or with locks bids fair to be passed upon by as able and well-informed a body of experts as could be brought together in the world.

Of course this is not the only question to be settled by the Board even though it be the one upon which all others hinge. Such interesting matters as the feasibility of dams at Bohio, as proposed by the late Geo. S. Morison, or at Gatun, as proposed by Major Cassius P. Gillette in our issue of July 27, or even nearer the coast, as proposed by Mr. Bates, are certain, we judge, to receive the careful attention of the Board. The particular feature of founding a great dam on a permeable layer of material is one on which Mr. Stearns of the Board is peculiarly competent to advise, in view of his experience as engineer of the great North Dyke at the Wachuset Reservoir. The extensive experience in river control of a large proportion of the members amply qualifies them to consider the serious problems of silt disposal which arise in connection with a sea level plan.

We might continue further; but the professional biographies on another page of this issue are ample evidence of the competence of the men selected as members of the Board. The point we wish particularly to emphasize is that the submission of these great questions to a body of chosen experts is exactly the proper course, and one which ought oftener to be chosen when difficult technical questions must be settled relating to public affairs. As the New York "Journal of Commerce" well says in a recent editorial:

> No person is competent to form a critical opinion upon the problems involved in such a work as the interoceanic canal across the isthmus of Panama without a thorough knowledge, not only of the facts of the situation, but of the engineering requirements, or without a judgment trained by special study and practical experience. Therefore it behooves lay critics, whether politicians and members of Congress or representatives of "organs of public opinion," to exhibit a becoming modesty and avoid dogmatism upon a subject with which they are so little qualified to deal. It is a case in which the maximum "credo experto" should be accepted.

Some one must form a judgment and decide how the great work at Panama shall be built. It is self-evident that the body of engineers which has been selected is better qualified to do this than Congress, better qualified even than the working staff on the Isthmus, who are often too occupied with details to have time for a large view of the problems before them. We see no reason why the public should not await the verdict of this international jury with entire confidence that it will be a wise and worthy one, by which the country may safely be guided.

The American Society of Municipal Improvements, judging from the successful convention which it held at Montreal last week, bids fair to become in fact if not in name a national society of municipal engineering. When this society was founded, a dozen years ago, it was proposed to include in its membership all classes of city officials; but with a few exceptions it is only the men engaged in municipal engineering work of one class or another who have made up the working membership of the society, and contributed the valuable papers in its proceedings. The fact that this has come about by a natural process of evolution is sufficient proof that a real need is felt by the engineers in charge of city work of an Association where they can interchange experience with other engineers engaged in similar work. That city engineers are actually finding benefit from membership in this society is well proved by the great distances traveled by several well known engineers located in the far South and West to attend the Montreal Convention.

Still greater benefits will be assured by an increase of membership, and now that the character of the society is definitely formed as an association of engineers for the consideration of engineering problems, there certainly ought to be a great influx of new members. The average engineer engaged in municipal work in a small city almost invariably has to work alone, unaided by the counsel and advice of his professional brethren. The opportunity of meeting once a year men from other cities engaged in similar work cannot fail to broaden his vision and prove helpful and instructive.

The suppression of both epidemic and endemic diseases is rapidly becoming a fight against the most ignorant and morally irresponsible classes of humanity. This is now being forcibly illustrated by the cholera outbreak in Germany, and has been and still is being shown by the yellow fever epidemic at New Orleans. In the case of the cholera now prevailing in Germany the disease appears to have found its way from Asia through Russia into West Prussia, and then to have spread to numerous points, the human agents responsible for the importation, as well as most of the German victims, being people in the humblest walks of life and devoid of knowledge of personal hygiene, to say nothing of public sanitation. At New Orleans a large percentage of the recent victims of yellow fever have been Italians. The ignorant of all races not only expose themselves and others to infection with the utmost recklessness, but they also try to conceal cases of sickness from the authorities through dislike of interference and, oftentimes, a dread of removal from friends and an unreasoning fear of ill-treatment in hospitals. We cite these facts because they and others of like nature contribute so mightily to negative the recent brilliant advances of both sanitary science and preventive medicine. We know that the cholera is spread by means of contaminated drinking water and food, and that yellow fever is spread by means of mosquitoes; we also know how to stamp out both diseases on those now comparatively rare occasions when they invade civilized countries having effective health protective organizations. The wholesome fear which these two diseases arouse wherever they appear, the one in Western Europe and the other in North America, have aided greatly in preventing their dissemination in recent years; and now that we know so well how to put them down we need expect fewer and less serious outbreaks with each coming decade.

It is only fair to those whom we have designated as the ignorant and careless classes to say, as will doubtless have occurred to many, that sanitary ignorance and carelessness is by no means confined to the illiterate and the poor. Cholera and yellow fever aside, progress in sanitation to-day is being retarded by ignorance and carelessness among *all* classes of the population. If the public had as great a fear of typhoid fever, pulmonary tuberculosis, and various other diseases as of cholera and yellow fever those diseases, also, would be under nearly if not quite equal control in the most progressive countries of the world. The cholera in Germany, for instance, some two weeks (or on Sept. 8) after the first cases were reported, had numbered but 123 cases and 39 deaths, but during those two weeks it had been given almost first place in the daily press of civilized nations throughout the world. Unfortunately, no one now living is likely to see the time when as much prominence will be given to a few scattered cases of typhoid fever; but that it and many other diseases might be reduced to small proportions within a generation if only the sanitary knowledge now available were universally applied is a fact that promises much for the future. We cannot so soon, if ever, attain the ideal, but we shall make no little progress in that direction. Hereafter health authorities must direct their energies more than ever before to the sanitation of tenement and other districts sheltering the ignorant, careless and dirty classes; and to the water, milk and food supplies of the people of those sections.

The Pennsylvania Railroad tunnel at Washington, D. C., which is described in this issue, is notable among soft ground tunnels for the large extent to which machinery is employed in its construction. Since the construction of the Hoosac Tunnel in America and the Mont Cenis Tunnel in Europe, the use of labor-saving machinery has been universal in rock tunnel work, and as the

years have gone on such machinery has been improved to a very high state of efficiency. To-day the engineer has at ready command for such work power drills and high explosives, electric light and haulage, and power derricks and steam shovels, and he makes free use of them all, even in works of small size. So intimately associated is power machinery with rock tunnel work nowadays that resort to hand methods of excavation is had only for the time it takes to instal the necessary power plant and machinery. The case is entirely different in soft ground tunneling. If we except the shield method, which is a special solution of a special problem, the methods of soft ground tunneling to-day are the hand methods of generations past in all their essentials. It is true, of course, that the tools used have improved, that the electric light has replaced the candle, and that mechanical haulage and hoisting are available and are used, but the excavation proper is performed by the pick and shovel wielded by hand. It is this fact that makes the extensive use of machinery in the Pennsylvania R. R. tunnel so noteworthy. In this work a large portion of the excavation is being done by steam shovels, the mode of procedure being to take out an annular ring by hand methods and erect the timbering therein and then, with the central portion of the tunnel clear of all timbering, to work a steam shovel on the core left by the removal of the annular ring. With the center core removed, there is left a timber-lined tunnel section entirely clear and sufficiently large to permit the construction within it of the permanent masonry. This condition permits the use of traveling forms and centers and traveling derricks for constructing the lining masonry and of a traveling hoist and conveyor for placing the concrete backing and the earth backfilling. In a word, there are had in a tunnel, conditions approximating open air retaining wall and arch construction. It is plain, of course, that such conditions cannot be obtained in all kinds of soil, but there are circumstances similar to those surrounding the Washington work where they can be obtained and where engineers may be prompted to seek them now that they have a successful precedent to encourage them.

In our issue of Feb. 16 there was published in this journal a personal furnished by a man calling himself Charles Francis and claiming to be a Member of the American Society of Civil Engineers, reporting the murder of Mr. John A. McDonald, M. Am. Soc. C. E., at Mariopol, Russia, by a Russian Colonel of Engineers. Later, in our issue of June 8, we published a contribution by the same party describing alleged experiences in Russia and reporting excesses and corruption among Russian army officers.

The man who furnished this contribution displayed an intimate knowledge of engineers and engineering matters and his story was accepted at its face value and published, together with some personal items which were furnished by him at a later date.

A short time afterward, however, we discovered that the writer of the article had no connection with the American Society of Civil Engineers, and we set about investigating the truth of his story. We have recently received a letter informing us that Mr. John A. McDonald is alive and well and has never been in Russia, and, so far as we are able to learn, the whole story concerning his murder and the alleged conditions in Russia is a pure fabrication.

The man who furnished us this story, and who later adopted the name of Charles de Nevers, is a Frenchman and speaks with a marked French accent. There is a Charles Francis who has been a member of the American Society of Civil Engineers since 1892 and resides at Davenport Ia., but he has no connection with the man above referred to, who has passed under that name.

We sincerely and deeply regret that we were imposed upon in this matter and our hearty apologies are due to the Russian engineering profession for having given publicity to the canard concerning one of their number. We give especial publicity to this correction as a matter of justice to all concerned, and also that others may not be deceived by this man de Nevers as were we and a number of other engineers in New York, who procured him employment and aided him in various ways, believing him to be what he claimed.

THE DOUBLE TRACKING OF RAILWAYS.

The railway system of the United States is mainly composed of single-track lines, only about 7 per cent. of the total mileage being double track, although of course this 7 per cent. includes the divisions of heaviest traffic. This limited amount of double-track line is due to the fact that most of the railways have been built to develop traffic, and in only a few limited cases have the traffic or financial conditions been such as to warrant the construction of a double-track line in the first place. The passing of trains is provided for by side tracks, and these are increased in number and length as required, sometimes ultimately forming short sections of double track. As the growth of traffic on individual divisions has passed beyond the capacity of single track and sidings, double tracking has been undertaken, but there are many single-track lines which are worked to their utmost capacity, and which it would probably be economical to convert to double track. The following table shows the development of second, third and fourth main tracks for a number of years, for the entire country and for several individual railways, and it also shows the proportions of double track to total mileage. This proportion, for the entire railway system, increases very slowly, from 5.76% in 1892 to 7.45% in 1904.

DOUBLE TRACK ON AMERICAN RAILWAYS.

Total Railway System.

	Total length. miles.	2d Track. miles.	3d Track. miles.	4th Track. miles.	Proportion of 2d track to Total p. ct.
1892	162,397	9,367	853	626	5.76
1895	177,746	10,640	975	733	6.00
1900	192,556	12,151	1,094	829	6.31
1902	200,155	13,721	1,204	895	6.85
1904	212,243	15,824	1,467	1,046	7.45
Individual Railways.					
Boston & Maine	2,290	513	8	2	22.40
N. Y., N. H. & H.	2,058	685	91	90	33.28
N. Y. Central	3,515	1,311	369	321	37.30
Phila. & Read	1,012	443	25*	—	43.77
Erie	2,315	742	16½	16½	32.06
Lehigh Valley	1,393	574	28	—	41.20
Del., Lack. & West.	957	512	—	—	53.50
Southern	6,727	59	—	—	0.88
Norfolk & West.	1,769	150	—	—	8.48
Ches. & Ohio	1,671	178	—	—	10.65
C., C., C. & St. L.	2,287	142¼	—	—	6.23
Illinois Central	4,340	654	73*	—	15.07
Chicago & N. W.	7,412	790	22	22	10.78
Chicago, Mil. & St. P.	7,130	447	6½	1¾	6.26
Chicago & Alton	915	107	—	—	11.69
Chicago & East Ill.	758	129	—	—	17.00
Denver & R. G.	2,461	62	—	—	2.51
Northern Pacific	6,036	92	—	—	1.52
Union Pacific	5,594	104	—	—	1.86

*Third and fourth tracks combined.

It would be quite unreasonable and erroneous to suppose that only 7 per cent. of the great railway system of this country needs two tracks for the handling of traffic. As a matter of fact, many risks are incurred and many accidents are more or less directly caused by the operation of fast and frequent trains on single track lines which are worked up to and perhaps beyond their proper capacity. It is true that considerable extensions of double track are being built, but (like the extensions of the block system) they are not sufficient to meet the requirements for the safe, efficient and economical handling of the ever-increasing traffic. To meet these conditions it may be roughly estimated that probably 20 to 25 per cent. of the railway mileage should properly have double track. It is generally assumed that when a single-track line, well provided with sidings, has a traffic of 50 or 60 trains daily (including an average number of passenger trains), its limit of economical capacity has been reached, and that it should be double tracked. But no definite limit can be set, as so much depends upon the conditions of the line and its traffic in each particular case, as shown by the statements quoted in another column. It is also to be considered that while it may be possible to handle a certain number of trains, this may result in an inefficient and uneconomical service.

It is of course very difficult to determine just when double tracking will be desirable or necessary in any individual case, but in another column we present some opinions on this matter. Leaving aside the question of the financial condition of the road and the conservative or liberal policy of the management (both of which are very important factors) the principal points for consideration may be listed as follows: (1) the amount and character of the traffic, its distribution or concentration) and its growth; (2) the actual and relative number of passenger and freight trains; (3) the present speeds and probability of increase in speed; (4) dangers and delays in handling the congested traffic; (5) the physical characteristics of the line; (6) the possibilities of increasing the capacity of the single track by such means as improvements in grades or alinement, the extension of sidings, the use of the block system, and the purchase of more powerful locomotives to haul longer and heavier (and fewer) trains; (7) the possible increase of traffic due to the greater facilities of the double-track line; and (8) the possibility that the existing traffic can be handled so much more economically on a double-track line as to warrant the expense of double tracking.

There is of course a much higher degree of safety in operating trains on double track, as there are no opposing trains to be considered, and in consequence the number of sidings is reduced, with a consequent reduction in the number of switches, while a majority of the switches can be arranged as trailing switches. The track maintenance work is also more easily effected, owing to the reduced number of trains on each track; while the fact of the trains running in one direction only enables the superelevation of rails on curves on grades to be adjusted to better advantage.

The traffic is also handled to better advantage on double track, from the standpoints of both the transportation and the motive-power departments. The detentions to trains are greatly reduced, while at the same time the locomotives are kept at work for a greater proportion of the time, instead of standing on sidetracks to wait for other trains. The highest efficiency and economy of locomotive performance are obtained when the engines are kept in nearly continual service, with only such detentions as are necessary for inspection, cleaning, road repairs, taking coal and water, etc. But on single track lines with heavy traffic, the engines may spend a considerable proportion of their time on sidetracks, waiting for opposing trains, which may very often be behind time. Thus the engines are lying idle as far as the railway service is concerned, but are burning fuel all the time. With a double track line, these delays would be eliminated and a smaller number of engines might be able to handle an even greater amount of traffic with greater promptness and economy.

This matter of road detentions to locomotives was reported upon at the annual meeting of the American Railway Master Mechanics' Association in June. From this report it appears that locomotives are in the hands of the transportation department for over 75 per cent. of the time, and that the greatest opportunities for increasing the mileage of engines lie in reducing the delays in service. In one particular record for a single month, which was an example of general conditions, an engine which spent 464 hours on the road had delays aggregating 266 hours, and 128 hours of these were due to "passing trains." The average speed of this engine for the time that it was in the hands of the transportation department was only 5.7 miles an hour, and the expensive character of such performance is too obvious to need much comment. We refer to the matter here because it is one feature that is often overlooked in considering the advisability of double tracking.

The double tracking of portions of single-track railways is now an important item in railway improvement works, being necessitated by the great and steady growth of traffic and the increase in speed of trains. As a rule this is done by widening the existing banks, cuts and structures, and laying the second track parallel with and close to the first. But in many cases the opportunity is taken to improve the operating conditions of the line as a whole or of the second track in particular. Thus the grades and alinement may be changed and double track cut-offs built. Work of this class on the Southern Ry. and the Cleveland, Cincinnati, Chicago and St. Louis Ry. was described in our issues of March 2 and 16 and April 6, 1905; in the last case an entirely new piece of double-track line forming

a cut-off 40 miles in length was substituted for the original single-track line, 54 miles in length between the same points. Sometimes, however, the improved location is confined to the second track. For instance, where the grades of the existing line are unfavorable to the direction of the heaviest traffic, the second track may be so located as to give more favorable grades. This may take the form of a single-track diversion, a new location being made for the second track and the improved operating conditions being obtained at the cost of a small amount of right-of-way and grading, the diversion being usually very short. This has been done on the Delaware, Lackawanna & Western Ry., and also on the Grand Trunk Ry., the latter road having made a long diversion for its new second track in the neighborhood of Durand, Mich. But even if the second track keeps within the old right-of-way, it need not necessarily have exactly the same grades as the original first track, but may be laid out with a view to the best and most economical handling of the traffic. This plan has also been used in some places by the Delaware, Lackawanna & Western Ry.

Where long passing sidings or relief tracks have been built, or where sidings have been extended and connected up, the line can often be worked as a section of double track. This plan is in use on some parts of the Pennsylvania Lines and the Cleveland, Cincinnati, Chicago & St. Louis Ry., the ends of the double-track sections being equipped with interlocking plants. With this arrangement, opposing trains can be so scheduled as to pass on a double-track section, thus ensuring increased facility and safety in operation. Another method of obtaining the increased safety and capacity of a double-track line has been adopted in several instances where two railways having single-track lines running approximately parallel for distances of several miles have combined to operate these as a double-track line. At each end of the section the necessary switches and connections are put in, with interlocking plants, and each line carries the trains of both railways in one direction only. An example of this is afforded by the joint use of the lines of the Chicago & Alton Ry and the Cleveland, Cincinnati, Chicago & St. Louis Ry. between Mitchell, Ill., and East St. Louis, 12 miles (Engineering News, April 6, 1905). Another example is the joint use of the lines of the Chicago, Burlington & Quincy Ry. and the Chicago, Milwaukee & St. Paul Ry. between St. Paul and St. Croix junction, 20 miles; the arrangement in this case includes the avoidance of a grade crossing, as the two single-track lines originally crossed about midway between the points noted, while now they are operated as a 20-mile stretch of double track.

A somewhat similar expedient (but one of limited application) is sometimes adopted where a railway has two or more routes (each single track) between the same points, and can distribute its traffic. Thus the Chicago & Alton Ry. has two routes between Bloomington and Springfield, one by way of Lincoln, 58.5 miles, and the other by way of San Jose, 72.5 miles. The greater part of the traffic goes south by the latter route, and north by the former, which is the main line. There is a similar case on the Illinois Central Ry. The main line between Chicago and New Orleans is double tracked from Chicago to Fulton (406 miles) and from Jackson to New Orleans (183 miles). Between Fulton and Jackson (333 miles by the main line) the company has a number of single-track lines, and by the use of these to form alternative routes any congestion of traffic can be avoided, thus facilitating the handling of traffic and also increasing the safety of operation. The management of the Cape Government Railways of South Africa (operating mainly single-track lines) has adopted the policy of building a double track for some distance on each side of large junction points, so as to avoid the blocking of traffic at junctions.

In the construction of important new single-track lines it is well to bear in mind the future double tracking, and the possibility of carrying out the construction in such a way as to facilitate and reduce the cost of the subsequent work of widening. In a number of recent cases, where a rapid development of traffic is in view, the grading has been done in part for double track; and sometimes the masonry for large bridges (or even for culverts) has been built for double track. It would be economical practice to double track a busy line before the capacity of the single track is reached, but this is not generally done, and the work of double tracking is made more difficult and expensive by the frequent and irregular delays to both work trains and traffic trains. These delays to the work trains, in getting clear of the track and waiting for trains that are late, seriously reduce the effective working time.

The work of double tracking often presents many difficulties due to the necessity of avoiding interference with traffic (which is usually heavy) and of carrying on the work expeditiously and economically. Where work is done by contract, one point of difficulty is that of assigning the responsibility for delays to traffic, and this cannot be done arbitrarily, but must be settled in amicable arrangement with the contractor if the best results are to be expected. In the specifications for roadway construction as adopted at the 1905 meeting of the American Railway Engineering and Maintenance of Way Association, there are special clauses relating to such work as the revision of existing lines or widening for additional tracks. One of these clauses is as follows:

> The contractor must arrange his work so that there will be no interference or delay in any manner with the train service of the company, and he will be responsible for any damage to the company's property caused by his acts or those of his employees. Whenever the work is liable to affect the movement or safety of trains, the method of doing such work must first be submitted for approval, without which it shall not be commenced or prosecuted. If continuous detentions occur to the train service, the company reserves the right to complete the work at the expense of the contractor, after giving him written notice.

This clause, as originally submitted, contained a provision for a penalty for each minute of delay to trains, but this was very strongly objected to in the discussion and was eventually struck out. In preparing for the double tracking of a busy line of the Union Pacific Ry., between Kansas City and Topeka, it was desired to avoid interference with traffic as far as possible, and the contractors were consulted in regard to a clause similar to that given above and including the penalty provision. They objected to it very strongly, not so much on account of the penalty clause, but on account of the difficulty in drawing the line as to the delays. Mr. J. B. Berry, Chief Engineer of the Union Pacific Ry., stated that the contractors all agreed that if they had to assume such a responsibility (with the uncertainty about the delays, trains being liable to come at almost any time) they would have to increase their prices very materially. The plan finally agreed upon was to put a flagman at each end of the piece of track under construction and a third flagman at the steam shovel, governing the movement of trains by a system of hand signals. These men were employed and controlled by the railway company, but their wages were paid by the contractor. In this way, a lower price was obtained and the work was done quite as expeditiously as if a penalty clause had been included in the contract. A similar practice has been adopted on the Lehigh Valley Ry. and the Minneapolis & St. Louis Ry., and with entirely satisfactory results.

The question of cost is one of prime importance, and some figures as to this are given in another column. In the first construction of any given road, the cost of a double-track line would be probably from 30 to 50 per cent. greater than that of a single-track line. As to the cost of double tracking on existing single track road, no figures can be given that will represent even an approximate average for general application, as it will depend entirely upon the character of the work in each case. The cost of grading for the second track has been estimated at 50 per cent. of that for the original single track, and the same percentage has been given for the entire work of double tracking. In other words, where a single track line has cost $50,000 per mile, it will require $25,000 per mile for double tracking. This is for a parallel track on the same right of way, but it has already been shown that very much double tracking takes the form of new single track or double track stretches of line to improve upon the alinement and grades of the original line. In such cases, there would be no definite relation of the cost of the new work to that of the old work. While we have mentioned the percentages noted above, since they have been given with more or less authority, it is probable that they are little better than guess work, and to be regarded merely as wide approximations that cannot be applied to individual cases or actual work without very careful investigation.

The question of double tracking has now often to be considered by interurban electric railways operating a frequent service, in its relation to the safety and regularity of the traffic. The conditions are of course very different from those existing on steam railways, as the traffic consists entirely of passenger trains (except in rare instances) and there are no fast or slow freight trains to be considered in relation to the passenger service. All the trains, therefore, are run on practically the same schedule, except where occasional "limited" or non-stopping trains are operated. In an article in the "Street Railway Journal," it is stated that a service of trains at 30-minute intervals in each direction (with passing points at 15-minute intervals) is considered the maximum that can properly be operated on single track. The only way to reduce the intervals without changing the location of the turnouts would be to double the service; this would involve meeting points only 7½ minutes apart and would make the switches too numerous and too close together for a high-speed road. Where double-tracking is not considered advisable, a half-hour service of trains each way is likely to remain the maximum, and increase in traffic may be provided for by increasing the number of cars to the train rather than by increasing the number of trains. It may be said, however, that as electric railways are usually laid out to avoid heavy construction work, the cost of double-tracking such lines would in general be very much less than that of double-tracking steam railways in the same district.

THE NEW SOUTH WALES GOVERNMENT RAILWAYS aggregated 3,281 miles on June 30, 1905, according to the annual report of the Railway Commissioners. This is the same as in 1904, no new lines or extensions having been built, but two lines aggregating 170 miles are now under construction. The engineering work for the year included rail and tie renewals, ballasting, and the substructure for a new bridge over the Nepean River at Penrith. At two points the grades have been reduced from 1.66% and 1.81% to 1.25% and 1.55%, respectively. There were 35,158,150 passengers carried, without any train accident resulting in loss of life. The average haul was 6.03 miles, and the average revenue 0.94 ct. per passenger per mile. The freight amounted to 6,549,791 tons, besides 174,424 tons of live-stock. The earnings were $18,420,080, and the operating expenses $10,960,735, or 59.50% of the earnings, as compared with 65.74% in 1904. The cost of these railways (including shops and rolling stock equipment, averages $65,630 per mile. Of the operating expenses, 13.33% were for maintenance of way and structures, and 27.79% for locomotive and car repairs and renewals. The equipment includes 623 locomotives, 1,122 cars in passenger service, and 12,613 cars in freight service. Besides the railways, the government owns and operates eight lines of street railway; two of these (85 miles) are operated by electricity, five (39 miles) by steam, and one (1.5 miles) by horse traction. The equipment comprises 81 steam locomotives, 76 steam cars, 31 cable grip cars, 639 electric motor cars, 79 trail cars, and 42 service cars. The steam and cable equipment is being gradually disposed of as the electric system is extended. New 80-lb. tee rails were laid on two lines, and on one of these the joints were made by welding with thermit. The earnings were $4,067,845 and the operating expenses $3,428,410, or 84.28% of the earnings, as against 83.89% in 1904. The cost of these lines (including shops and rolling stock equipment) has averaged $144,655 per mile. The number of passengers carried was 139,669,459. The total number of employees of both the railways and tramways was 17,668. Mr. Walter Shellshear is Acting Engineer-in-Chief for Existing Lines; Mr. W. Thow, Chief Mechanical Engineer; Mr. G. R. Cowdery, Engineer for Tramways; and Mr. O. W. Brain, Electrical Engineer.

THE LOCOMOTIVE SHOPS of the Illinois Central R. R. at Chicago (Burnside) are to be enlarged at an expenditure of about $300,000. The new building will include an erecting and machine shop, a 30-stall roundhouse, a boiler shop 550 × 120 ft., and a car shop 360 × 160 ft.

THE FLORIDA EVERGLADES: THEIR LEGAL STATUS, THEIR DRAINAGE, THEIR FUTURE VALUE.

By S. L. Lupfer.*

Of the states east of the Mississippi River, Florida stands preeminent as the one whose agricultural possibilities are least developed. A number of industries might be mentioned in which Florida excels her sister states; but to look through a Government Agricultural Report and note her standing in agriculture is discouraging to any Floridian who takes pride in his state.

But Florida has one possession, the Everglades, of which no other state can boast and which Governor Broward and a number of his friends believe will yet make her one of the richest states in the Union, even though that possession is at present nothing but a morass, inhabited only by birds, 'gators, snakes and mosquitoes. The Everglades surround Lake Okeechobee in the southern central part of the state, and from there stretch due south one hundred miles to Cape Sable, varying from 20 to 40 miles in width and covering an area of over 3,700,000 acres. See Figs. 1 and 2.

There are stretches of prairie land in this, and there is considerable cypress timber, but the most of it is a saw-grass marsh, with a soil from 3 ft. to 15 ft. in depth, covered with a few inches of water the greater part of the year. During an exceedingly dry season, water can only be found in the sloughs or runs, which extend in every direction, but even then it is impossible to walk over this marsh—it being too soft and boggy. At such times the "'gators" gather to the water holes, and if a hunter can penetrate to these places he is sure of a harvest of "'gator plumes."

During and after the rainy season—which usually extends from June to September—when the Kissimmee Valley has poured all of its rainfall into Lake Okeechobee and filled up the "glades," it is quite easy to get about through the tortuous channels—provided you use a small skiff.

It is impossible to tell how long these marshes have been forming, but the writer has seen a large cypress tree, which had over five hundred rings, taken out by the roots and found that the stump was immediately over a log fully as old, showing that the first tree was growing over a thousand years ago.

THEIR INACCESSIBILITY.—Between 1837 to 1860 several U. S. Army officers who were stationed on the eastern coast of Florida, attempted to explore the "glades," but very few ever succeeded in crossing them. In 1892, Col. J. E. Ingraham, now 3d Vice-President of the Florida East Coast R. R., crossed them about 40 miles south of Lake Okeechobee; and during the last ten years probably a dozen or more hunters have traversed the entire length of the glades from Lake Okeechobee to Miami, so that the mystery which hung over the Florida Everglades is gradually being dissipated, and, as the Indian hunter camped miles out in the glades, hears the whistle of the midnight train on the East Coast railroad (as the writer has done), he must realize that the Everglades, as a hunting ground, will, ere long, be a thing of the past.

THEIR FERTILITY AND EASE OF DRAINAGE.—Whoever has examined the soil of the Everglades grows enthusiastic as to its fertility —and no one has ever questioned the practicability of their drainage. In 1848 the U. S. Senate investigated the feasibility of their drainage, and I quote the opinion of two Army officers.

Gen. W. S. Harney, U. S. A., writing on Jan. 23d, 1848, said:

> During the Seminole War I was repeatedly in the Everglades, and on the rim or margin at different points, and crossed it from Miami to Shark River. Of the practicability of draining them I have no question. That such work would reclaim millions of acres of valuable lands, I have no doubt. My plan for doing the work would be to dig a large, deep canal from Okeechobee to the Caloosahatchee on the West side, and smaller canals from the glades into the heads of the Rattones, Little River, Arch Creek, Miami, Shark River and other outlets on both sides of the peninsula. I am satisfied that were these canals and drains once opened, the glades would become dry. It is my opinion that it would be the best sugar land in the South, and also excellent for rice and corn. It could in that latitude be made valuable for raising tropical fruits, and it is the only region in the present Southern States where they can be raised. I do not know of a project that I regard as more calculated to benefit the country than this. It affords the Union the best kind of cultivated land that is wanted to render us, to a great extent, independent of the West Indies.

Gen. Thomas S. Jessup, writing to Hon. J. D. Wescott, U. S. Senator, Feb. 12, 1848, said:

> From my own observation when commanding the Army operating in that country (Southern Florida) ten years ago, as well as from reports made by and information derived from intelligent officers who operated near and explored the Everglades and the large Lake Okeechobee north of them, I have no doubt the Glades are about 30 ft. above the level of the sea. The practicability of draining I take for granted. The effect of the measure would be to reclaim many hundreds of thousands of acres, without including the bed of the Everglades, now subject to inundation several months of the year. Were the surface of the Lake and the Glades lowered, these fine lands would be reclaimed and soon be converted into valuable sugar plantations as rich as any in the world.

Prof. H. W. Wiley, Chief Chemist of the U. S. Agriculture Dept., said (in the published report of the Sec. of Agriculture for 1891):

> In regard to the depth of soil, it runs most curving at the edges of the sand to from 15 to 16 ft. It may be said then with confidence that in the region of Lake Okeechobee the land which may be recovered for sugar making purposes has all the advantage of the climate of Cuba. The manufacture of sugar from cane of this region may be postponed with perfect safety until the beginning of February, and the months of February, March and April made of greatest activity in sugar manufacture.
>
> The enormous crops of vegetables which are grown on the saw-grass lands on New River, which is really a part of the Everglades, prove the truth of the above statement in regard to the fertility of the soil.
>
> The lands of the Everglades are of the same character as those drained by the Disston people near Kissimmee some years ago, on which cane was successfully grown until the sugar plantation was turned into a stock-jobbing, speculative, grab game. On these lands sugar-cane was grown which yielded from 25 to 40 tons per acre, and as to its richness in sucrose I attach some figures of analyses made at different times by Dr. H. W. Wiley of the Agriculture Dept. at Washington, who in writing of several of the samples, said: "You will see from the analyses that these canes are of very high grade and quite equal to the best canes grown in Cuba and the Hawaiian Islands."

Date.	Sucrose.	Purity.	Reducing sugars.
Dec. 9	14.61%	84.90%	.78%
Feb. 5	13.60	83.4	.97
6	15.15	84.9	.54
6	14.7	85.5	.77
13	14.	82.3	.80
13	13.2	81.5	1.00
Apr. 6	17.3	88.7	.24
6	16.6	89.5	.36
10	17.2	89.6	.54
10	16.	86.	1.00
15	17.	85.	1.24

With these analyses, it is not hard to believe that on the St. Cloud plantation the yield was over 6,000 lbs. of dry sugar to the acre, for an entire month's run; and remembering these figures, we can readily believe sugar men when they claim that from the products of the Everglade lands, standard granulated sugar can be laid down on the docks at New York City for 2½ to 2¾ cts. per lb.

WHAT HOLDS THE WATER IN THE GLADES?—Along the eastern edge of the Everglades there is a ledge of rotten limestone, slightly higher than the surface of the glades, which in a measure holds back the water from overflowing the adjacent lowlands. This statement is only applicable to an ordinary stage of water, as when the water in the glades reaches a certain height, it overflows this ledge of rocks and floods all the prairie between the glades and the Atlantic Ocean—distant from five to ten miles. At a number of places the water has cut through this rock and formed rivers, of which the principal ones are the Hillsborough, New, Little and Miami.

In order to drain the Everglades it would be necessary to widen and deepen these rivers where they have cut through the rock reef and then extend them by a system of canals until Lake Okeechobee was reached. After cutting through this rock reef, nearly all the excavation necessary would be through sand and muck, as on a three days' trip which the writer took last summer—going west from the head of New River—only once was rock touched with a ten foot sounding pole, and that was just at the south end of Long Key and was probably a continuation of the rock which underlies the Key. By extending these rivers or drainage canals out into the Everglades, and making them large enough, the whole of the Everglades could be made available for agricultural purposes, thus fulfilling that old adage: "That man is a public benefactor who makes two blades of grass grow where one grew before."

FIG. 1. MAP OF SOUTHERN FLORIDA, SHOWING LOCATION OF EVERGLADES.

THE DISSTON DRAINAGE CONTRACT.—In 1880, Mr. Hamilton Disston, the Philadelphia saw manufacturer, became interested in the drainage of the Everglades and entered into a contract with the Board of Trustees of the Internal Improvement Fund for the drainage of an immense tract of land covering about 5,000,000 acres. By the terms of this contract the Drainage Company was to receive every alternate section of the land drained, and did receive a considerable amount; but neither the Drainage Company nor the trustees were satisfied with this contract, and a few years later it was modified so that the Drainage Company was to expend a specified amount of money, for which it was to receive a certain amount of land. Even this was not a

*Kissimmee, Fla.

perfect panacea for its troubles, for, though the Drainage Company received nearly 2,000,000 acres of land, and still claims over 300,000 acres, one of the first acts of Governor Jenning's administration in 1901 was to give it legal notice that it was not entitled to any more land under this contract.

In the Everglades proper, at the head of the Caloosahatchee River, the Drainage Company cut probably 25 miles of canal, but the work was done in such a manner that not a foot of land was reclaimed, nor will the work done be of any great benefit to any other company who at some time might drain this land.

In the Lake Hart region, 100 miles north of Lake Okeechobee, about twenty miles of canal were excavated, and while the general level of the lakes was lowered, the work was never finished, the Drainage Company having expended the amount of money it had agreed to—and none of the marsh land is available for agricultural purposes, being liable to overflow at any time.

In the Kissimmee district alone—where there had been excavated about fifteen miles of canals—was there any marsh land drained, and, although that was liable to overflow every few years—fine crops were grown on it.

THE ST. CLOUD SUGAR PLANTATION.—Under the management of Capt. R. E. Rose, the St. Cloud Sugar Plantation was established on these lands near Kissimmee, and immense crops of sugar cane were grown, showing that the land was thoroughly adapted to cane growing.

Mr. Disston, feeling that the weight of his Florida investments had become too much for him to carry alone, had induced other parties to become interested with him in this enterprise, and turned the management of the plantation over to them. Under this general management, local managers were changed almost every year, the policy of working the crops was dictated from the Philadelphia office, the name of the company to whom the plantation belonged was changed as often as two and three times a year and the sugar plantation was used as a speculative investment to catch "suckers." In 1895, Mr. Disston practically assumed control again, and it looked very much as if a success would be made, but in May, 1896, Mr. Disston died and his heirs disposed of all his Florida investments and let the sugar industry die. Had Mr. Disston lived a few years longer, or had he been allowed to dictate the policy of the company, the St. Cloud sugar plantation would be making sugar to-day.

THE STATE'S TITLE TO THE EVERGLADES.—In 1856, the U. S. Government, realizing how sparsely Florida was settled and how difficult it would be to induce railroads to build through a wilderness, such as Florida was at that time, granted to the State, to aid in building railroads, every alternate section in a strip twelve miles wide, running from the Alabama line south to Pensacola, then east to Jacksonville, then southwest to Cedar Keys and Tampa. This was in addition to the 500,000 acres granted to the State in 1841 for internal improvements, and neither of these acts had any connection with the "Swamp and Overflow Act" of Sept. 28, 1850. This last named act enabled Florida and other States to construct the necessary levees and drains to reclaim the swamp and overflowed lands within their borders. Among other things, the act provided that the fee simple title to said lands should vest in the said States "subject to the disposal of the legislatures thereof; provided, however, that the proceeds of the said lands—whether from sale, or by direct appropriation in kind—shall be applied, exclusively, as far as necessary, to the purpose of reclaiming the said lands," etc. Under this act the State received about 20,000,000 acres of land, "the proceeds of which," the act itself says, "shall be used *exclusively* for their own drainage."

BOARD OF TRUSTEES CREATED.—In accepting the "Swamp and Overflow" lands from the U. S. Government, it became necessary to place them under the control of a Board of Trustees, and the Legislature of the State created the "Internal Improvement Fund," naming the Governor, Comptroller, Treasurer, Attorney-General and Commissioner of Agriculture as the trustees; and into their hands was placed, "irrevocably" the handling of these lands. During the "reconstruction" days this Internal Improvement Fund became heavily involved, and in the latter '70's there were claims against this fund amounting to $1,000,000, which Mr. Disston and his associates paid off before entering into a contract with the Board of Trustees for the drainage of a large area of the Everglades—receiving therefor 4,000,000 acres of land, and leaving the rest free and unincumbered.

Until this time no one had thought of giving any of these lands for railroad construction, for several reasons, among which were the very good ones that the lands were covered by a judgment, and that the U. S. Government had granted land along the railroad lines which were then building, to aid in their construction. But the legislatures of the early '80's were railroad legislatures—they believed in building railroads and opening up the State to immigration; and any company which would agree to build a good road could secure a land grant of from 5,000 to 20,000 acres for every mile built; and, if the State owned no land contiguous to the line building, it would be given land perhaps several hundred miles distant. Some of the railroads were rather slow in having their lands deeded to them—thus saving the payment of taxes—and the land grant roads still claim 2,000,000 acres—of which amount the Pensacola & Atlantic—now a part of the Louisville & Nashville R. R. System—claims over a million.

GOVERNOR JENNINGS CAUSES TROUBLE.—Until Governor Jennings was inaugurated, in 1901, the public land question had not been discussed. When a "land grant" railroad asked for its land it received it, and the Board of Trustees did not make any distinction between "Swamp and Overflowed" land, and that granted by the Government for railroad construction. When, however, the first demand was made of Governor Jennings, and he refused to grant any swamp land to the railroads, it caused a commotion among the railroads of the State.

The Governor took the position that the U. S. Government had granted these lands to the State for their reclamation and drainage, and that the law had not intended these lands should be given to the railroads, who had not built perhaps within two hundred miles of them. He further contended that when the legislature created the Board of Trustees, of which he was now chairman, and "irrevocably" placed these lands in their hands, that they—the legislature—ceased to have any control as to the disposition of the lands, and consequently could not grant them to the railroads.

RAILROADS BRING SUIT.—The Louisville & Nashville R. R. Co. soon afterwards brought suit in the U. S. Court presided over by Judge Swayne—who has recently figured so prominently before the public—for the recovery of the balance of the land due it by the Board of Trustees. Its claim was that it had built 161 miles of road between Pensacola and River Junction, in the extreme northwestern portion of the State, for which it was to receive 20,000 acres per mile or a total of 3,200,000 acres; that it had only received 2,202,000 acres; that the legislature some years before had granted it a large body of the Everglades, to the south of Lake Okeechobee, and prayed that the court would compel the Board of Trustees to deed it this land. The Board of Trustees fought this suit on the ground given above, and it reached a point where the next move must be made by the railroad company. That point was reached in 1902, and the case still rests there.

In 1903, the Florida East Coast R. R. Co.—Mr. H. M. Flagler's road—brought suit in the State courts against the Board of Trustees for the recovery of 2,040,000 acres of land, lying in the Everglades, for building that road from Daytona to Miami. If any road in the State is entitled to land in the Everglades, it is this road, as it has done wonders in the southern section of its territory; but the Board of Trustees also fought this suit on the same grounds that it had fought that of the L. & N. R. R. Co., and also, that this was not a "land grant" road. This company also rested its case as soon as it had obtained an injuction preventing the trustees from disposing of any of the State lands. These suits, however, were causing the people to think of the public land question.

THE EVERGLADES THE ISSUE IN THE GUBERNATORIAL CAMPAIGN.—Early in the summer of 1903, Col. Robt. W. Davis, who had represented the Second Congressional District since 1896, and who apparently had a mortgage on that office, announced that, at the expiration of that term, he would retire from office and again take up the practice of law. The announcement caused a great deal of surprise as it was supposed Col. Davis would, ere long, aspire to the U. S. Senate. Before long it was hinted that he would like to be the next Governor, and in a few months it was publicly announced that "Our Bob," who was loved by the people of his district as few Congressmen are, would be a candidate in the Democratic primary for the nomination for Governor. Against the record of Col. Davis in Congress nothing could be said; his integrity was above suspicion, and yet—when people began to think—did he not represent railroad companies before the Board of Trustees, securing for them millions of acres of land? Was he not being groomed for the Gubernatorial race by the railroad organs? These and other questions arose in the minds of the people who were supporting the policy of the Jennings administration, and men of influence determined that the railroads should not elect their man without some show of opposition.

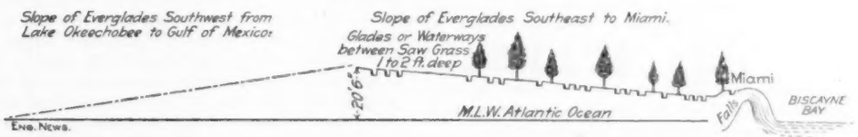
Slope of Everglades Southwest from Lake Okeechobee to Gulf of Mexico
Slope of Everglades Southeast to Miami.
Glades or Waterways between Saw Grass 1 to 2 ft. deep
20'6"
Miami
M.L.W. Atlantic Ocean
Falls
BISCAYNE BAY
Eng. News.

FIG. 2. SKETCH SHOWING SLOPES OF EVERGLADES TO THE SOUTHWEST AND THE SOUTHEAST.

But the question was, who should enter the lists against Col. Davis? It meant months of touring the State, wear and tear on the conscience as well as on the nerves, and a big hole in the pocketbook. Whoever went into it must know that every newspaper, of any consequence would be against him, and that the corporate interests would not hesitate at anything to defeat him. There were already two men in the field, but no one looked on these men as cutting any figure in the race, except to force Col. Davis and his opponent into the second primary, as no one expected any one man to have a majority of the votes polled; and, to be declared the nominee, required a majority.

Had Governor Jennings not been barred, by the constitution not allowing a governor to succeed himself, he would have been the people's choice, as he was already fighting the railroads to save the Everglades; but he was out of the question and the place went begging for the proper man.

After maneuvering for a month or more, the mantle fell on Capt. N. B. Broward, of Jacksonville, who had made a national reputation as a "filibuster" just previous to the Spanish-American war, and he was put forward in the early days of January, 1904, as the candidate for Governor who was opposed to the railroads owning the State.

Of the first campaign there is little to be said,

as the greatest interest was devoted to local politics, but the State candidates sent out tons of literature and every Democratic voter in the State received a "personal" letter from each one of the candidates, and during the whole of the fight the floor of every postoffice was littered with campaign documents.

While Broward's campaign took in other issues, yet the great issue—the Everglades—was kept constantly to the fore. A large map of the Everglades, on the reverse side of which the whole situation was given, was mailed to every voter in the State, and at every political meeting Capt. Broward stated his position on this question and demanded of the other candidates that they state their's. Although Capt. Broward and Col. Davis spoke from the same platform fifteen or twenty times, and Capt. Broward asked him each time what attitude he would take on this question, he refused to answer and pointed to his record in Congress.

At the first primary, on May 10, Capt. Broward led the ticket, receiving about 1,500 more votes than Col. Davis received, and every one then realized that until June 7, the date of the second primary, there would be "Hot times in the old State." Both the other candidates had agreed, should they not be in the second race, to throw their strength to Broward; but within a week both of them were openly supporting Col. Davis.

Realizing that they were fighting for 8,000,000 acres of land, the railroad and turpentine interests poured money into the campaign like water. Newspapers that had supported Broward in the first race were bought outright; turpentine operators were instructed by their factors to support Davis; money was sent into evey county in the State for electioneering purposes, and so openly and flagrantly did the corporate interests enter into the fight, that it hurt Col. Davis' candidacy, and Capt. Broward was nominated by nearly 1,000 majority, and the first popular victory over the railroads had been won. In the November election Capt. Broward received the support of all the "powers" that opposed his nomination and was elected by the usual majority.

HOW BROWARD KEPT HIS PLEDGES.—Within two weeks after his inauguration in January, Governor Broward employed ex-Gov. Jennings, N. P. & W. J. Bryan, Cockrell & Son, of Jacksonville, and Williams of Tallahassee, to represent the Board of Trustees in the various land suits pending, with instructions that no time should be lost in pushing them to a conclusion; and in a month from that time the governor took a trip to Lake Okeechobee and then down the east coast to learn for himself the conditions surrounding the drainage of the Everglades. So well did these attorneys follow Gov. Broward's instructions that early in March they had succeeded in having Judge Malone, of the State Circuit Court, dissolve the injunction by which the East Coast R. R. had "tied up" 2,040,000 acres; and on March 15, in a case between private individuals, Judge Wall, another judge of the State Circuit Court, made a ruling which practically covered the same ground.

The principal plea made in both of these cases was, that after the legislature turned the "Swamp and Overflow" lands over to the Board of Trustees, they—the legislature—lost all control of these lands and had no power or right to grant them to anyone else for any purpose. There is no doubt that these cases will be taken to the higher courts, and there seems to be little question in the minds of the trustees and their counsel that they must finally win their cause.

So thoroughly did Governor Broward impress the legislature—which met in April—with his views in regard to the State draining these lands, that when a bill, which embodied his suggestions, was introduced, it was passed with only four votes recorded against it, in both houses, and in order to make the act secure, a joint resolution for an amendment to the Constitution of the State, embodying this act, was also passed.

This act provides for a "Drainage Board," of which the governor is chairman, and gives this board the authority to lay out "Drainage Districts" in which they may levy a tax, not to exceed ten cents per acre per annum, on all swamp or overflow land in that district, and to expend the money so collected in the drainage of these lands.

So rapidly did the governor move, that by July 1 he had created a drainage district, which embraced the whole of the Everglades, and the tax assessors of the various counties which had lands in this district had on their books an assessment of 5 cts. per acre on every acre of swamp land which lay inside of this drainage district. On July 26 the Trustees of the Florida Internal Improvement Fund ordered a preliminary for a canal, under the direction of J. O. Frees.

Since Governor Broward's election, and especially since his inauguration, his actions have been such that all fair-minded men, even those who fought him the hardest, and honestly believed that he would be partisan and biased in his official acts, are admitting that they were mistaken in the man, and that he is governor, not of a faction, but of all the State.

Every member of the Board of Trustees is with Governor Broward in his fight for these lands, and each one of them realizes how their drainage would cause the State to prosper, as the Everglades would be cut up with canals for drainage and transportation purposes and where now is a morass, through which one is barely able to pass with a skiff, then you could go anywhere you wished in a good-sized steamboat; where now nothing grows but saw-grass, then these canals would be bordered with vegetable farms and immense sugar cane plantations; where now not a single hut is standing on an area covering over 3,000 square miles, then the whole country would be dotted with immense sugar refineries and clustered around each of these would be a village of a thousand inhabitants; where now there is not a single inhabitant—except a solitary hunter who pitches his tent for a few weeks—then these lands would support a happy, contented, agricultural population of half a million souls.

This is the prize for which Governor Broward is striving, and he and his friends believe that before his term expires, the accomplishment of this will be far past the embryo stage.

The State of Florida has never had a cleaner, more business-like administration, than that of Governor Jennings, but the present one promises to be as good, and if in addition to that, Governor Broward shall open up the Everglades and thus place Florida where she can produce all the sugar which the United States consumes, then, for all the time to come, Floridians will point with pride to the present administration, and the Everglades, reclaimed and densely populated, will be a fitting monument to Napoleon B. Broward.

THE GRAND TRUNK PACIFIC RY.

The first contract has been awarded for the new Canadian transcontinental railway. This contract is for the grading of the section from Portage la Prairie, in Manitoba, west to Touchwood Hills, 275 miles. The contractors are Macdonald & Macmillan, of Westbourne, Man., and work has actually been commenced. Both the Canadian Pacific Ry. and the Canadian Northern Ry. pass through Portage la Prairie, and the former has protested against the location of the new line, on the ground that it parallels the Canadian Pacific Ry. at a distance of only about ten miles, and that there is not sufficient business for two lines. The protest suggested that the new line should be at least 30 miles from the existing railway, but the location has been approved by the government and will not be changed. The work will be comparatively light. In the meantime the Canadian Northern Ry. is rapidly pushing its two lines across the northwest, to Prince Albert and Battleford, in the Saskatchewan district, and it is supposed that the company has a Pacific terminus in view, while it is already building to connect its western system with its eastern system, which latter reaches both Montreal and Quebec.

The next part of the Grand Trunk Pacific Ry. to be put under contract will be the branch line from Winnipeg to Lake Superior (at Fort William) so that grain from the Northwest can be delivered to lake steamers. The specifications for the first 100 miles indicate some very heavy work. There will be 2,000 acres of clearing, and the earthwork quantities per mile average 2,000 cu. yds. of solid rock, 2,500 cu. yds. of loose rock, and 60,000 cu. yds. of earthwork. Plans are already being made for terminals and harbor facilities at Fort William. The Canadian Pacific Ry. and the Canadian Northern Ry. both have lines in operation between Winnipeg and Fort William, and the former has recently awarded a contract for double-tracking its line, owing to the difficulties of handling the enormous grain traffic from the Northwest. The Canadian Northern Ry., also, has obtained authority to build a line east from Fort William to connect with the new James Bay line and the Great Northern Ry. of Canada, which it owns and by which it will get access to Montreal and Quebec as Atlantic shipping ports. It will be thus in competition with the present Canadian Pacific Ry.

The general contract for the entire line of the Grand Trunk Pacific Ry. from Winnipeg to the Pacific coast and to Lake Superior has been awarded to the National Construction Co., which was organized for the purpose and is composed of officers of the present Grand Trunk Ry. It is reported that contracts for the eastern division of the line, from Winnipeg to Moncton, N. B., will not be let for some time. This division is to be built by the government (under the direction of a Transcontinental Railway Commission), and operated by the Grand Trunk Pacific Ry. Mr. Collingwood Schrieber is Chief Engineer of the Commission, and Mr. D. B. Kelliher is Chief Engineer of the Grand Trunk Pacific Ry. A full and illustrated description of this new trancontinental railway was given in our issues of Oct. 22 and Nov. 5, 1903. The whole line is to be completed and in operation by the end of 1911, or say six years for 3,600 miles of the main transcontinental line, 220 miles of the Lake Superior branch, and 250 miles of the branch to North Bay, Ont., giving a line to Toronto.

A GAS ENGINE ELECTRIC PLANT AS AUXILIARY AND RESERVE FOR A LONG-DISTANCE TRANSMISSION SYSTEM.

A power plant of remarkable character, now being built for the California Gas & Electric Co., which owns the famous water-power electric long-distance transmission system in southern California, was described in brief outline at the recent annual meeting of the Pacific Coast Gas Association by Mr. John Martin. The plant is to consist of three generating units each of 4,000 KW. capacity, in which the power end is a gas engine. The fuel on which the engines will operate is gas made from crude oil, with a calorific power of about 650 B. T. U. per cubic foot, or slightly superior to ordinary coal gas. The following sketch of these engines is taken from the paper referred to.

The engines are, in general arrangement, of the twin tandem type, and operate on the four-stroke or Otto cycle; each crank thus receives two impulses per revolution. The working parts are wholly above the engine-room floor. The general design is developed for maximum accessibility, easy access to interior of cylinders, and proper realinement in re-assembling. Any cylinder head can be removed from its cylinder by disconnecting one jacket-water supply pipe and removing the holding-on nuts. Each cylinder is in two parts, with a circumferential joint halfway between the ends.

The pistons are carried by cross-heads, to reduce the friction load on the cylinder walls; each rod has three cross-heads: main, intermediate and outboard, the piston rod being continuous from the main to the outboard cross-head. The crank shaft has overhung cranks, integral with the shaft forging; the crank-pins are forced into the shaft.

Lubrication of the pistons is done by four oil feeds to each cylinder, with individual oil pumps. Oil is pumped in on the admission stroke, and is spread on the compression stroke. The journals are also lubricated by positive feed. The (mul-

tiple) oil pump allows of separate regulation of feed to each part supplied. The oil feed starts and stops with the engine.

Starting the engines is done by compressed air, stored in tanks. Speed limiting devices are fitted. Special attention has been given in the design of the engines to reducing the angular variation of speed, so that parallel operation of the generators may be successfully accomplished.

The main dimensions of each of these engines are: Cylinders, 42 ins. diameter by 60 ins. stroke; main bearings, 30 ins. diameter by 54 ins. long; shaft, 38 ins. diameter; flywheel, 130,000 lbs.; over-all dimensions of engine, 70 ft. long by 34 ft. wide; total weight of engine (with generator), 600 tons. The engines are being built by the Snow Steam Pump Works, of Buffalo, N. Y.

THE MOURAS AUTOMATIC SCAVENGER: AN ALLEGED ANTECEDENT OF THE SEPTIC TANK.

In the legal battles now being fought over the septic tank as a partial means of sewage purification those who are trying to disprove the validity of recent septic tank patents rely largely upon the patent for "The Automatic and Odorless Scavenger" granted to the Frenchman, Mouras, nearly twenty-five years ago. Mouras' French patent was dated Sept. 22, 1881, and his American patent bears date of Nov. 28, 1882. In the recent opinion of the U. S. Circuit Court of Appeals, in the Pawtucket case (see news note and editorial note, Eng. News, Aug. 31, 1905) the specification of the French patent is printed, apparently in full. Believing that both the interest and convenience of many of our readers will be served thereby we reprint the specification from the court decision, as follows:

THE AUTOMATIC AND ODORLESS SCAVENGER.

Description of the Apparatus.

This apparatus of extreme simplicity is composed firstly of three agents viz.:

(1) An air-tight tank hermetically closed of a capacity in proportion to the needs it is to satisfy.

(2) A feed pipe B sealed to the top of the tank and destined to receive evacuations, slops and rain water.

(3) An elbow pipe C likewise fastened to the upper part of the tank, and serving to discharge the sewage contained in the tank.

The feed pipe B, as well as the discharge pipe C, both well sealed, are to plunge from 10 to 15 centimeters into the liquid in the tank. This is what closes it hermetically.

Construction of the Tank, the Scavenger.

The tank, the scavenger, may be constructed in all kinds of forms and of all kinds of materials. For small households, which wish to practice economy, it may be reduced to a simple sheet-iron cask placed anywhere, provided that this cask is furnished with a receiving pipe and a discharge pipe communicating with a sewer pipe.

Our tank being easy and inexpensive to construct, the owner or architect may place it anywhere in the house, even in the narrowest closet. Besides, as it is odorless, cesspools may be established even in the interior of the rooms without the least inconvenience.

The first condition to fulfil in the construction of this tank is to leave it perfectly air-tight.

Its covering may, at will, consist of slabs or of a mason work arch, of bricks, of concrete, cement or any other material; but it should be made so that in no case the outer air can get into this tank, which, to be protected from changes in temperature, should always be hermetically closed. This is the second condition to fulfil.

Mode of Operation of the tank.

The tank A does not begin to operate until it is completely full of water. If then there is let in through the receiving pipe B any volume whatever of water or faeces, immediately an equal volume of water is expelled by the discharge pipe C, sealed at the upper part of the tank.

But we must carefully note that the discharge pipe never passes anything but a turbid water holding in dissolution a certain quantity of matter coming from the *decomposition and disaggregation of matter going on at the bottom of the tank.*

For the proper working of the apparatus it is expedient to discharge into the receiving pipe, as much as possible, rain water and dish water, in short all water that can be disposed of, in order to facilitate in the tank the decomposition and disaggregation of faeces and all other decomposable matters which may chance to be there.

The tank constructed as we have just said, there can be no escaping of gas, no emanation whatever, either by the tank A which is air-tight and hermetically closed, or by the feed pipe B, which plunges into the water to the depth of 10 to 15 centimeters.

Under ordinary normal conditions the tank always acts as we have just said. However, there is a case, but a very exceptional one, in which the tank will be unable to perform its functions, and that is when, in the long run, in consequence of the carelessness of negligent servants, the tank will be completely filled by the accumulation of foreign substances, such as bones, broken dishes, and kitchen refuse of all kinds which shall have been thrown into it through the reservoirs. It is incontestable that in such a case the owner, to clean out his tank, will be obliged to use the ordinary means of cleaning. But, we repeat, this will be an exception and nothing but an exception. Furthermore, even in the very unfavorable supposition which we have just foreseen, it is only after a very long lapse of time, a century perhaps, that there will be occasion to clean out the tank.

In any other case, one will never be obliged to open the tank and summons the nightman, and we say so with this certitude and assurance furnished by the twenty years' experience during which time the system has never failed to perform its functions with the greatest success in the home of the inventor.

To conclude we will say that our system is far from being one of those experiments more theoretical than practical, which await the sanction of experience; but that on the contrary it has shown what it can do. The twenty years during which it has worked with the greatest success in the house of the inventor testify clearly that the tank, the scavenger, is one of those serious inventions of general utility which have only to be produced to be immediately accepted and sought after by the public.

The Court then makes some other interesting citations, which we append:

In commenting on the Mouras invention, M. Moigno, in the *Cosmos des Mondes* for Dec. 21, 1881, and Jan. 21, 1882, says:

I had been prepared for a long time, by personal observation, to accept and explain to myself in a sufficiently satisfactory manner the incredible facts M. Mouras has been in possession of for twenty year.

The automatic scavenger is, in fact: First, hermetically sealed and closed by the most inviolable of fastenings, hydraulic fastenings, that is to say, its contents are cut off from all contact with the surrounding atmosphere. For that very reason; second, it is absolutely odorless and renders all infection impossible. Third, by a mysterious operation and one which reveals a quite new principle, it transforms all it receives, solid and liquid excrements, in a rather short space of time and without addition of chemical ingredients, into a homogeneous liquid, only slightly turbid, and holding everything in suspension in the form of scarcely visible filaments, without leaving any deposits on the sides of the evacuation pipe or at the bottom of the drain pipe. Fourth, it empties itself automatically and continuously; that is to say, each volume of new evacuations introduced by the feed pipe immediately drives out an equal volume of old evacuations worked over and fluidized. Fifth, the liquid which escapes, while it contains all the organic and inorganic elements of the evacuation, is almost odorless and may be received on the spot into a watering cart for agricultural purposes or may flow away of itself into the branch pipe at first, then into the street sewer, then into the main sewer, and at last into canals for irrigation of prairies, fields, forests, etc.

Respecting septic action, it was said before the English Society of Arts, in 1886:

During spontaneous subsidence, which is a much slower process than precipitation, fermentation sets in. Solids are converted into liquids, and both solids and liquids into gases.

On the same subject, M. Moigno wrote, in January, 1882:

The mysterious agents of fermentation causing the decomposition and liquefaction of the faeces are the vibrions or anaerobic bacteria which, according to Pasteur, are destroyed by oxygen, and which manifest their destructive activity only in vessels from which the air is excluded.

THE WORST ELEVATED RAILWAY ACCIDENT in the history of the elevated railways of New York City occurred at 7 a. m., Monday, Sept. 11. A train on the Ninth Ave. line of the Manhattan Ry. (Interborough Rapid Transit Co.), which took a curve at excessive speed, was derailed and one of its cars fell to the street. Twelve persons were either killed outright or died soon after the accident, and over a score of persons were very seriously injured; the list of minor casualties is very large.

The accident was of unusual character. It occurred at 53d St. and Ninth Ave., where the Sixth Ave. line branches off the Ninth Ave. line, the latter continuing south on Ninth Ave., while the former runs eastward into 53d St. The structure on Ninth Ave. has three tracks, of which the outer two are the northbound and southbound "local" tracks, while the center track is used for express trains running without stop between 14th St. and 116th St., southward in the morning and northward in the evening. The Sixth Ave. line has only two tracks, which branch from the "local" tracks of the Ninth Ave. structure by a 90° curve of 80 to 100 ft. radius. The outer track on this curve has no superelevation, as it crosses two lines of track at grade. The junction of the Sixth and Ninth Ave. tracks is fitted with dwarf semaphore and lamp signals, interlocked with the switches; switches and signals are operated by a switchman in a cabin placed on the west side of the Ninth Ave. structure on the center line of 53d St., where a clear view is open along all the tracks concerned. Traffic on the "local" tracks of the Ninth Ave. and Sixth Ave. lines is about equally dense; during the rush-hours both lines are loaded to their maximum traffic capacity (limited mainly by the capacity of the junction in question). This results in almost constant operation of the switches at the junction, to pass trains to their proper tracks. It is important to note, also, that the Ninth Ave. tracks at 53d St. are on a fairly heavy down grade southward, the grade extending several blocks either side of the junction. In consequence, when a southbound Ninth Ave. train approaches the junction, and the operator sets switches and signals clear for it, the train will go through the switch at a fair rate of speed. Sixth Ave. trains, on the other hand, always take the curve at extremely slow speed.

The accident in question happened to a southbound Ninth Ave. train during the morning rush hours. As it approached the junction, the switchman, mistaking it for a Sixth Ave. train in spite of the characteristic signals displayed by the train, set the switch for the turnout into 53d St. The train came on at good speed, the motorman thinking the track was clear ahead for him, although the switch signals indicated that the switch was set for the turnout. When the train entered the curve the second car, a trailer, left the rails, tore loose from the first car, and crossed the tracks diagonally, running off the east side of the elevated structure just south of the 53d St. tracks. The front end of the car fell to the sidewalk, while the rear end remained leaning against the structure. The third car of the train was partly dragged off the rails by the car in front of it, and ran forward so that its front end overhung the street; the front truck of this car fell to the sidewalk, striking the other car and adding to the destruction. The other three cars of the train remained in place on the rails. The first car of the train, a motor car, remained on the rails and came to a stop just beyond the curve, on 53d St. The switchman at the junction is under arrest, while the motorman has disappeared. It was at first reported that the switchman had derailed the second car by throwing the switch under the train when he saw that the train was for Ninth Ave. As the switch is interlocked with detector bars, this could not have occurred. The present opinion is that the derailment was due simply to excessive speed for the sharp curve. The train was fairly crowded; the second car contained about 75 passengers, of whom about twenty-five were standing.

AN EXTENSIVE AND VIOLENT EARTHQUAKE devastated the province of Calabria, in Southern Italy, on Sept. 8. Several thousand persons were killed and very great property damage is reported. The volcanoes Vesuvius and Stromboli were reported strongly active for some days before the shocks.

THE OIL FIELDS OF BAKU, in the Caspian Sea Region of Russia, are threatened with greatly reduced producing capacity because of conditions of absolute anarchy prevailing in the surrounding districts. Rioting and conflicts between Tartars and Armenians and government troops resulted in the destruction of much of the oil companies' property at the wells, the damage running into many millions of dollars. It is said that if government aid in securing loans for reconstruction is not obtained, many of the companies will be unable to resume working.

AN INTERNATIONAL ARCHITECTURAL COMPETITION is announced for the Palace of Peace at The Hague, Holland. The program for the competition was issued on August 11, and designs must be handed in within seven months from that time. A sum of about $650,000 is appropriated for the building. All details and explanations will be supplied, on application, by Mr. D. E. C. Knuttel, Fluweelen Burgwal, The Hague.

THE SIERRA LEONE RAILWAY has been completed and turned over by the contractors to the colonial government. It is a line of 30 ins. gage extending 225 miles from the Atlantic port of Freetown to Baima, near the frontier of Liberia. The line opens up an almost unexplored section of Africa, and is largely in rough country, crossing a number of rivers with bridges 500 to 700 ft. long.

PERSONALS.

Mr. Z. N. Vaughn has been appointed City Engineer of Boise, Idaho, succeeding Mr. Godfrey Sperling, whose term has expired.

Mr. H. S. Moore has been appointed Chief Engineer of the Missouri, Oklahoma & Gulf Ry., to succeed Mr. F. C. Faust, resigned.

Mr. Herbert Spencer, Jun. Am. Soc. C. E., Assistant Engineer in Charge of Contract No. 1 of the New York State Barge Canal is now located at Fort Miller, N. Y.

Mr. E. H. Pfafflin has been appointed Engineer of Way and Structures of the Southern Indiana Ry., as well as of that company's new line from Terre Haute to Chicago.

Mr. James F. Parr, formerly Assistant City Engineer of East St. Louis, Ill., has been appointed Assistant Engineer of the Missouri Pacific Ry., with headquarters at St. Louis, Mo.

Mr. L. J. McIntyre has resigned as engineer of the New York Terminal Division of the Erie R. R. to accept a position as Assistant Engineer with the Chicago & Northwestern Ry.

Mr. A. S. Robinson, during the past season with The Fitz-Simon & Connell Co., of Chicago, has been appointed Local Manager of the MacArthur Brothers Co., with headquarters at Sault Ste. Marie, Mich.

Messrs. C. O. Vandeventer, R. W. Palmer and S. P. Daniel have been appointed Division Engineers of the South & Western Ry. Mr. M. J. Caples has been appointed General Manager of that road.

Mr. Irving A. Chandler, Jun. M. Am. Soc. M. E., Designing, Consulting and Constructing Engineer, has announced the removal of his engineering office from 1 Broadway to 120 Liberty St., New York City.

Mr. John M. Ewen, M. Am. Soc. C. E., has been appointed supervising architect for the County Board at Chicago, in charge of the erection of the new County Building, the architects of which are Holabird & Roche, of Chicago.

Mr. W. L. Hope, heretofore Division Engineer of the Chicago, Rock Island & Pacific Ry., at Chicago, has been appointed Train Master of the Dakota Division, with headquarters at Estherville, Ia., succeeding Mr. A. B. Copley, promoted.

Mr. H. F. Stratton, who has been connected with the principal office of the Electrical Controller & Supply Co., at Cleveland, O., has accepted the position of New York representative of the same company, with offices at No. 136 Liberty St., New York City.

Mr. William R. Strickland, for the past year Assistant Engineer in the Maintenance of Way Department of the New York Central & Hudson River R. R., has resigned that position and is now associated with J. C. White & Co., 43 Exchange Pl., New York, as Assistant to the Secretary.

Mr. R. B. Burns, Chief Engineer of the Atchison, Topeka & Santa Fe Ry. Co. (Coast Lines) has been granted leave of absence, until January 1, 1906, for a much needed rest. His many friends will be glad to know that he has not broken down, and the first of next year, will find him in his office again.

Mr. E. M. Grime, until recently Division Engineer of the Fort Dodge Division of the Chicago Great Western Ry., has been appointed Division Engineer of the Northwest Division, with headquarters at St. Paul, Minn., to succeed Mr. H. W. Church, who has resigned to engage in private business.

Mr. H. W. Woodcock, Jun. Am. Soc. C. E., formerly Assistant Engineer of the Brooklyn Grade Crossing Commission, Brighton Beach Improvement, in charge of all construction work in connection with the elimination of grade crossings on the Brighton Beach Division of the Brooklyn Heights R. R. Co., has been appointed Assistant to the General Superintendent of the Brooklyn Grade Crossing Commission, of Brooklyn, N. Y.

Mr. W. S. Doran formerly associated with The British Westinghouse Electric & Manufacturing Co., Ltd., has been appointed Manager of the Power Department of Allis-Chalmers Co., with headquarters at the general offices of the company, Milwaukee, Wis. Mr. Doran became associated with the British Westinghouse Electric & Manufacturing Co., Ltd., in 1901. Previous to that he was with the Worthington Pumping Engine Co., Ltd., with headquarters in London, England.

Mr. Joseph B. Bishop, Chief of the Editorial Staff of the New York "Globe," has been appointed Executive Secretary of the Isthmian Canal Commission, with headquarters at Washington, D. C. Mr. Bishop will have charge of the literary publicity branch of the Commission, and also will be official historian of the Isthmian Canal, preserving and compiling the authentic and authoritative record of its construction. Mr. Bishop has had a great deal of experience as a magazine and newspaper writer and has made a special study of the canal problem.

Mr. H. F. J. Porter, M. Am. Soc. M. E., has opened a consulting engineering office in the Metropolitan Building, 1 Madison Ave., New York City, and is prepared to give advice in general manufacturing and mechanical engineering questions tending toward industrial betterment, and also to install "welfare work." Mr. Porter has opened this office primarily to fill the demand for some one who has had experience in establishing modern methods and management in industrial establishments where older and cruder methods exist, and where assistance is needed to effect changes along lines which have been proved to be efficacious.

Obituary.

Patrick Delaney, an expert designer and builder of boilers, and head of the Delaney Boiler Works of Newburg, N. Y., died August 29 in that city. He was born in Ireland in 1842.

Thomas H. Wells, for many years a coal and iron operator died Sept. 1, in Youngstown, O., aged 91. He was a member of the engineering corps which was in charge of the first section of the Pennsylvania Railroad.

R. M. Daelen, one of the most prominent engineers in the German iron and steel industry, died at Baden-Baden on August 2, aged 62 years. Born at Lendersdorf in 1843, he obtained his schooling and rolling-mill apprenticeship in Germany, spent two years at Creusot, and after some several years in various undertakings in Germany, he settled into engineering practice at Düsseldorf, continuing until his death. He did important early work in studying power-consumption in rolling, contributed to the development of the hydraulic forging press, for which he invented the steam intensifier, and in recent years contributed to the development of open-hearth practice.

Vernon H. Rood, M. Am. Soc. M. E., Vice-President and General Manager of the Jeanesville Iron Works, Hazleton, Pa., died suddenly, Sept. 2, at Bad Nauheim, Germany, where he had gone for the benefit of his health three weeks ago. Mr. Rood was born in Elyria, O., Nov. 10, 1856, and was a son of the late Homer B. Rood. He was a graduate of the Stevens Institute of Technology. He was married Dec. 21, 1882, to Miss Alice A. Stone of Oberlin, O. Shortly after his marriage he located at Jeanesville. For the past 15 years Mr. Rood has devoted his entire time and energy to the perfection of mine pumps and during that time he achieved a great deal of success. Not only did he bring the Jeanesville Iron Works from the position of a small local manufacturing plant into that of one of the largest makers of mine pumps in the anthracite fields, but his name as pump designer has spread to a world-wide reputation and the business of his company is to-day an international one.

F. C. Rossiter, one of the oldest surveyors and civil engineers of Chicago, was struck by a train and killed at Hammond, Ind., on Sept. 6. He was just completing a land survey and had a tape stretched across the track of the Lake Shore & Michigan Southern Ry. when he heard a train approaching, and called to his son to remove the tape. As the latter failed to hear him, he started to reach the tape when he was struck in the back by the train and thrown from the track. He was put on the cars but died as the train reached Whiting. Mr. Rossiter was born at Oberlin, O., in 1844, and as a boy worked on a farm to earn money to enable him to go to school. In 1866 he went to Oshkosh, Wis., and was for a time a fireman on the Chicago & Northwestern Ry., but went to Chicago in 1867 and entered the employ of the surveying firm of Wolcott & Fox. In 1870 he was Assistant Engineer of the Milwaukee & Northern Ry., resigning to become City Engineer of Chicago. After the great fire of 1871 he was Assistant Engineer of the Rockford Central Ry., but resigned in a short time to assist in the difficult work of the resurvey of Chicago. He was deputy county surveyor of Cook County for six years, and engineer of Rosehill Cemetery for 16 years, and in 1880 was engineer of the Union Stockyards & Transit Co. He was a member of the Illinois Society of Engineers and Surveyors for many years, and was also a member of the Western Society of Engineers.

Prof. Franz Reuleaux, of Berlin, Germany, pre-eminent in mechanical engineering circles for decades past, died on Aug. 20, 1905, at the age of 76 years. Franz Reuleaux was born on Sept. 30, 1829, at Eschweiler, near Aachen, the son of proprietor of a small machine shop. He obtained his technical schooling at the then famous Polytechnic School of Karlsruhe, under the noted Redtenbacher, and following this, 1852 to 1854, studied at the universities of Berlin and Bonn. For the next two years he was manager of a machine building works in Cologne, leaving this work to follow a call to the Zürich Polytechnic School, which at that time was rapidly forging to the front. Among his colleagues at Zürich was Zeuner; the latter devoted himself mainly to prime movers, while Reuleaux gave his attention to the development of the science of mechanism. He introduced the study of kinematics, originated in France, and greatly developed it. During his period at Zürich, also, he published what is perhaps his best known work, "Der Konstrukteur," which has gone through a number of German editions and has been translated into several foreign languages, English among them. In 1864 he left Zürich to go to Berlin as professor at the Berlin Trade School, and four years later he was named director of the school, remaining with it until 1879. In this time appeared his "Text-book of Theoretical Kinematics," the fruit of his labors at Zürich. In 1879 Reuleaux was called to the newly-founded Technical College of Berlin, where he remained for 17 years. A work supplementary to his "Theoretical Kinematics" appeared in 1900, under the title "The Practical Relations of Kinematics to Geometry and Mechanics," with an appended chapter on Kinematics in the Animal Structure. Besides his instructional work, Reuleaux was active in many ways as member of public commissions, member of exposition juries, etc. Most noteworty was his deputation to the Philadelphia Centennial Exhibition as representative of the German Empire, in 1876. His reports on this exhibition, specifically on machinery, wherein he strongly emphasized the inferiority of German machine production and characterized it as cheap and poor, aroused great protest at home. But his criticisms brought rapid and great results in improvement of German manufacture, and may, perhaps, be considered one of the moving causes of this improvement. Professor Reuleaux' services to applied science were recognized by many technical or scientific societies by election to honorary membership. Among others, he was honorary member of the American Society of Mechanical Engineers, being one of the first to be distinguished. He was also honorary member of the American Philosophical Society, the Verein für Eisenbahnkunde, the Verein zur Förderung des Gewerbefleisses, the Technischer Verein of Frankfort a/M, the Société des Arts of Geneva, the Naturforschende Gesellschaft of Zürich, and others. McGill University, of Montreal, Canada, conferred upon him the honorary title of Doctor, and the Karlsruhe Technical College the honorary title of Doctor of Engineering. Reuleaux held the government title of Geheimer Regierungarat.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 18 to 20. Annual meeting at Bethlehem, Pa. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 25 to 29. Annual meeting at Boston, Mass. Secy., Dr. Chas. O. Probst, Columbus, O.

AMERICAN STREET RAILWAY ASSOCIATION.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION.

STREET RAILWAY ACCOUNTANTS' ASSOCIATION.
Sept. 25-30. Annual convention at Philadelphia, Pa. Secy., T. C. Penington, 2020 State St., Chicago, Ill.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17. Annual meeting at Pittsburg, Pa. Secy., R. F. Patterson, Concord, N. H.

LAKE SUPERIOR MINING INSTITUTE.
Oct. 17, 18. Annual meeting on the Menominee Range, with excursion. Secy., A. J. Yungbluth, Ishpeming, Mich.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

WESTERN SOCIETY OF ENGINEERS.—The first meeting of the season was held at the society's rooms in Chicago on Sept. 6, when Mr. F. H. Bainbridge, Principal Assistant Engineer of the Chicago & Northwestern Ry., presented a paper on "Structural Steel Dams." He prefaced his paper with a description of an old wooden dam 12 ft. high, having inclined timbers supported by vertical posts and inclined braces, the face being formed by planking laid longitudinally upon the inclined timbers. Stone and concrete dams, and rock-fill dams with steel plate core walls were also referred to. The paper described two existing steel dams, and Mr. Bainbridge stated that another is to be built across the Missouri River at Helena, Mont., which will be 75 to 80 ft. high. Mr. I. K. Sherman remarked that an inspection of the steel bear-trap dam on the Chicago drainage canal showed that the point under water was in very much better condition than that on parts exposed to the air. Mr. C. F. Loweth spoke of a curious concrete dam built as an arch and having a vertical cross section resembling a crescent, with the convex side upstream. Mr. E. E. R. Tratman, Associate Editor of Engineering News, referred to a type of dam proposed for some of the works of the Reclamation Service and described in Engineering News June 11, 1903. Mr. E. C. Carter described a type of concrete dam in which the downstream toe or apron was of considerable width and of trough shape so as to form a deep basin of water to receive the shock of water falling over the dam.

AMERICAN ELECTROCHEMICAL SOCIETY.—At the coming annual meeting of the society, to be held at Lehigh University, Bethlehem, Pa., September 18 to 20, 1905, the following papers will be presented: "A Standard Method of measuring the Specific Resistance of Electrolytes," by R. Threlfall; "Notes on the use of Aluminum as a Reducing Agent," by O. P. Watts; "Notes on the Electrical Resistivity of Iron and Steels at High Temperature," and "A New Gin Furnace for the Electrical Manufacture of Steel," by G. Gin; "An Electroiytic Process for Refining Silver," and Notes on the Electrometallurgy of Antimony," by A. G. Betts; "The Electro-chemical Exhibits at the Louisiana Purchase Exhibition, 1904," by Prof. C. F. Burgess; "Artificial Willemite," by Prof. Charles Baskerville; "The Chemistry of Electrochemistry," by Prof. W. D. Bancroft; "Ammeters for Electrolytic Works," by L. Addicks; "Electrolytic vs. Sulphuric Parting of Bullion," by F. D. Easterbrooks; "Insulating Paints," by M. Toch; "The Utilization of Active Oxygen, Chemically and Electrically Produced," by R. von Foregger; "Some Tendencies in the Design of Electric Incandescent Lamps," by E. F. Roeber; "The Chemical Separation of the Excited Activity of Thorium," and "Radioactivity of some Natural Waters of Missouri," by H. Schlundt and R. B. Moore; "Some Observations on the Influence of Arsenic in Pickling Solutions," by Prof. C. F. Burgess; "The Electric Smelting of Zinc," by O. W. Brown and W. F. Oesterle.

The society will have its headquarters during the meeting at the Eagle Hotel. Numerous excursions have been arranged, to technical and other points of interest. Meetings for the reading of papers are scheduled for 3 p. m. Monday Sept. 18, 9 a. m. Tuesday and 9 a. m. Wednesday. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, September, 14, 1905.

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Reviews.

Williams and Hazen's Hydraulic Tables.

Reviewed by Leonard Metcalf,* M. Am. Soc. C. E.

HYDRAULIC TABLES.—Showing the Loss of Head Due to the Friction of Water Flowing in Pipes, Aqueducts, Sewers, Etc., and the Discharge over Weirs. By Gardner S. Williams, M. Am. Soc. C. E., Professor of Civil, Sanitary and Hydraulic Engineering, University of Michigan, and Allen Hazen, M. Am. Soc. C. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 75; diagrams. $1.50

Clear, concise, and well arranged, hydraulic engineers will find this new book upon a hackneyed but always interesting subject, a valuable addition to their working libraries. It is not a treatise upon hydraulic computations, but essentially a series of hydraulic tables relating to friction losses in pipes, simplifying the work of the designer and of service to those who prefer to make use of tables rather than the slide rule.

Engineers familiar with the use of the Hazen and Williams' slide rule, brought out by them a year or two ago, will value the book chiefly on account of the collection of experimental results which it contains, and which will assist them in determining the coefficient of friction to be used in any given case. Others, who have not learned the utility of the slide rule, will find the tables in convenient form for computation.

The tables, as the slide rule, are based upon the formula

$$V = Cr^{0.63}\ s^{0.54}\ _{0.001} - 0.04$$

The formula† may also be written in the form

$$H_f = \frac{3.0212\ V^{1.85}}{C^{1.85}\ D^{1.17}}$$

This formula, it will be observed, is a modification of the well-known Chezy formula, selected by the authors, no doubt, on account of the familiarity of engineers with that formula. The Chezy formula is open to the objection, however, that the value of the coefficient C used in it

$$(V = C\sqrt{RS})$$

depends not only upon the roughness of the pipe, but also upon the slope and hydraulic mean radius as well, and further study of experimental results has seemed to indicate that a formula of the "exponential" type may be devised for any given set of conditions which will show smaller variation in the value of C than will be found in the application of the Chezy formula, with the value of C in it determined by Kutters' formula. The authors say:

> The exponents in the formula used were selected as representing as nearly as possible average conditions, as deduced from the best available records of experiments upon the flow of water in such pipes and channels as most frequently occur in water-works practice. The last term,
>
> $$_{0.001} - 0.04$$
>
> is a constant, and is introduced simply to equalize the value of C with the value in the Chezy formula, and other exponential formulas which may be used, at a slope of 0.001 instead of at a slope of 1.

In regard to the accuracy of the tables, the authors state:

> All the computations of figures contained in this volume except a few fundamental ratios, have been made with the slide rule, and only such accuracy has been sought as can readily be obtained by this method of computation.

In view of the uncertainty attending the selection of the proper coefficient for any formula, this accuracy is sufficient. In this connection it is interesting to observe that the hydraulic slide rule has distinct merit over hydraulic tables for use in computation, for the reason that it absolutely prevents the engineer from carrying his computations to an unwarranted degree of refinement. Many engineers are constant sinners in this respect, carrying their results to many more significant figures than circumstances justify, and too much emphasis cannot be laid upon this kind of self delusion.

Table 1, upon pipe values, contains a concise statement of the results of experiments of various observers upon pipes of different materials and sizes—of old and new cast iron, steel, wood and cement pipes and brick tunnels, of diameters from 3.22 to 144 ins.; of pipes of wrought iron, brass, lead, glass and wood, of smaller diameters, from ⅛ to 2 ins., and of rubber-lined fire-hose. The range of velocities covered by the experiments, the corresponding value of C in the Hazen and Williams' formula and the mean value of C are also shown. The table includes substantially all of the more recent and best American experiments upon pipe lines now in service, thus far reported, and the laboratory experiments upon pipes of smaller diameters sufficiently comprehensive to be of practical value to the engineer, and one finds in it of course the older classical experiments of Darcy, Hamilton Smith, Jr., Stearns Kuichling, Fitzgerald, Herschel and others.

Table 2 gives similar values for open channels of different sizes, based upon the observations of Darcy and Bazin, Fteley and Stearns, Horton, Baumgarten and Cunningham upon conduits, aqueducts, sewers, sluiceways and canals.

The average practicing engineer who finds so little time in the pressing demands of an active practice to study carefully the details of the mass of technical literature and bosh that has been written upon the subject of the flow of water in pipes and channels and who has difficulty in keeping in mind the work of individual experimenters, will find these brief but admirable tables very helpful in assisting him to determine the value of the elusive and yet fundamental coefficient C to be applied to the formula for flow in his computations.

Next follows a table of friction losses in small brass, lead, tin or copper pipes under velocities of flow from ½ to 5 ft. per sec.; and a table for small pipes from ⅛ to 1¼ in. in diameter, with interior surfaces of different character. Then follow tables for velocity heads and friction losses in pipes from 1½ to 144 ins. in diameter for a wide range of velocities and conditions of the pipe surface. The values corresponding to the coefficient for ordinary use are shown in bold-faced type and the author's suggestions as to changes to be made in the coefficient for increasing age of the pipe line are clearly indicated.

The data upon relative discharging capacities of aqueducts (pages 49 to 51) is less complete and convenient and is not altogether clear to the reader at a glance.

On pages 52 to 62 follow friction tables for sewers, Venturi meters and filter underdrains; and an interesting general comparison of the loss of head of water in pipes of various ages as computed by the authors' formula and the formulas of Freman C. Coffin and Edmund B. Weston. This indicates that for cast iron pipes of small diameter and low velocities (one foot per second) the Hazen and Williams' formula gives generally speaking greater friction losses, which increase with the age of the pipe; while for pipes of large diameter the Hazen and Williams' values lie between those of the other two experimenters, closely approaching Weston's results. Under velocities of 5 ft. per sec., the author's values also lie between those derived from the Coffin and Weston formulas.

Concerning the loss in carrying capacity of any pipe with the lapse of time, the authors say:

> The gradual roughening of the interior of cast-iron pipe is one of the most familiar of water-works phenomena. It is also one of the most difficult to compute. In a general way it may be said that in a series of years, which is not long compared with the total life of the pipe, the roughening of the surface and the reduction of the area through rusting and tuberculation reaches such an extent that twice as much head is consumed in sending a given volume of water through it as was the case when the pipe was new.

The authors then suggest as a means of computing the decrease in the value of the coefficient of discharge C to be used in their formula for cast iron pipe, with average soft unfiltered river water through a period of years, the following assumptions.

> (1) Assume that the original value of C is 130.
> (2) Assume that the increase in loss of head due to tuberculation, etc., amounts to 3% per year.
> (3) Assume that the diameter of the pipe is reduced by tuberculation at the rate of 0.01-in. per year, and that the value C must be modified to correct for this.

They give (page 58) a table based upon these assumptions. This table indicates that the carrying capacity of a 4-in. pipe is reduced by one-half in about 40 years, a 6-in. pipe in 50 years, a 12-in. in 60 years, a 24-in. in 70 years, a 48-in. in 80 years, etc. While these results are at best rough approximations, the authors believe them to be in consonance with the best data available. For hard water and lake waters the reduction is generally considerably less than for soft and clear, but unfiltered waters to which the tables refer.

The book closes with an excellent discussion of the experiments of Francis, Fteley and Stearns, and Bazin upon the flow of water over weirs, and is accompanied by convenient tables, based upon the Bazin formula. Corrective factors or multipliers have also been worked out and presented for application to the Bazin formula in determining discharge over flat crested, triangular, and compound wiers, based upon the experiments of Professor Williams made at the Cornell Experimental Hydraulic Laboratory, if the reviewer is not mistaken.

Criticism of this brief but serviceable little book is perhaps unjust when the authors state quite frankly in their introduction that it is founded upon their hydraulic slide rule and is not a treatise; yet the reviewer cannot refrain from expressing the hope that the next edition of it may contain a few diagrams based upon its contents, for experience has shown that greater rapidity in hydraulic computations is possible with a compact diagram as a supplement to the slide rule—in determining the position of the decimal point and in preventing error—than with hydraulic tables.

A brief comparison of the corresponding values or range of values of C in the Hazen and Williams' formula with C in the Chezy formula would also appeal to many busy engineers who will use this book, and the pages upon aqueducts and aqueduct sections could be improved and amplified to good advantage. It remains yet for some one to treat the latter subject in a comprehensive and satisfying way.

The limits of this review forbid a discussion of the Hazen and Williams' formula itself and engineers will doubtless prefer to draw their own comparisons and conclusions. It is interesting, however, to note the tendency of the times toward the use of the exponential formula and to compare the results of recent experiments at home and abroad which have been persented in this way. These experiments certainly seem to justify the existence of the exponential type of formula, and confirm the practical applicability

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†A discussion (by the reviewer) of this formula in its different forms with accompanying diagrams based upon it, will be found in the issue of The Engineering Record of June 20, 1903.

of the Hazen and Williams' formula to general uses. The authors have done engineers a genuine service in making hydraulic computations based upon their formula easy of solution through the use of their slide rule and these later tables.

French Studies on the Brittleness of Iron and Steel.

Reviewed by Mansfield Merriman.*

CONTRIBUTION A L'ETUDE DE LA FRAGILITE DANS LES FERS ET LES ACIERS.—Memoires Originaux et Reimpressions. Publication faite avec le concours des six grands compagnies de chemins de fer francais par la Societe l'Encouragement pour l'Industrie Nationale. With an introduction by H. le Chatelier. Paris: The Society (Rue de Rennes, 44). Paper; 9 × 11¼ ins.; pp. 482; numerous plates and many illustrations in the text. 20 fr.; American price, $6.

This volume contains reprints of papers on the brittleness of iron and steel published since 1888, with a few original articles. Twenty-one authors, mostly French, are represented, and the discussions cover almost every phase of the subject. By way of preface H. Le Chatelier gives a concise and interesting summary of the conclusions of the authors. Since many of the original papers were printed in journals not readily accessible to American readers, this reprint will be welcomed by all who desire to study the many experiments which have been made on the brittleness of materials.

A brittle material is one which ruptures under a small amount of applied work with but slight change of shape. There are different degrees of brittleness which can only be expressed in a comparative way, and that material is said to be the most brittle which undergoes the least change of shape when ruptured under a given force or by the expenditure of a certain amount of work. Brittleness depends, as Le Chatelier clearly points out, upon two entirely different circumstances, the first being the nature of the material itself, and the second the conditions under which it is ruptured. The quality of iron and steel depends upon its chemical composition and its structure as influenced by method of manufacture. The conditions of rupture include the quickness with which the external forces are applied, the shape of the test specimens, and temperature. Hence, speaking mathematically, brittleness is a function of two independent variables, each of which is entirely independent of the other.

With regard to the chemical composition of iron and steel, it has long been known that carbon, sulphur and phosphorus are elements which promote brittleness. Cast iron is brittle because of its high percentage of carbon, and the high steels are more brittle than the soft ones for the same reason. Phosphorus renders iron and steel brittle and the more so the lower the temperature. Sulphur causes brittleness, but its influence is mostly felt at high temperatures. The influence of sulphur may be largely counteracted by the addition of manganese, but there seems to be no antidote for phosphorus, and unfortunately the higher the carbon the greater appears to be the influence of phosphorus in increasing brittleness. With regard to structure, it has long been known that cast metals are more brittle than rolled ones, that forging and annealing decreases brittleness while tempering promotes it. Moreover, the form in which carbon exists in the steel plays a most important role, and this is largely influenced by the temperature from which the metal is annealed or tempered. The so-called "heat treatment" in connection with the microscopic examination of steel has received great attention during the past decade and the principles which govern it may now be said to be fairly well understood. Through such treatment steel may be rendered of a homogeneous structure and this of itself tends to remove one of the causes of brittleness.

With regard to the external conditions which promote brittleness, that of the quick application of the load, commonly called shock or impact, has long been known to be more dangerous than a static load or one applied slowly. Regarding the relative amounts of work necessary to cause rupture under static and dynamic loads, there seems to prevail different opinions. The common opinion, which seems to be verified by the experiments of Considère and A. Le Chatelier, is that a bar under shock is stressed so quickly that there is not time for the deformation to occur; hence the elastic limit is almost as high as the tensile strength, so that rupture occurs with but a small permanent set, and hence the work expended is small compared with that in static tests. On the other hand, the experiments of Fremont and Charipy on beams indicate that the work expended in dynamic flexure is practically equal to that required for static loads, while the tests made by Fréminville on certain special steels show that the amount of work required to produce rupture by shock is much greater than that for static loads. This question is, therefore, yet unsettled, and probably the varying results are due to differences in the manner of conducting the impact tests.

Concerning the effect of temperature on brittleness, numerous tests have shown that, although the static strength of steel increases with decreasing temperature its strength under impact becomes less. It is said to be a common custom to immerse chains in warm water when they are to be used for hoisting heavy loads in cold weather, but this is done to decrease brittleness and not to increase static strength. Tempered steel in particular has a high degree of brittleness when the temperature falls below the freezing point. On the other hand, an increase in temperature diminishes brittleness, so that it mostly disappears before 300° is reached.

The shape of a test piece has an influence upon brittleness. Corners and sharp angles allow an opportunity for rupture without deformation and hence should be avoided. A notched tensile specimen gives a slightly greater ultimate strength in a static test and a much lower elongation, and hence it is said to be more brittle. Notched or nicked bars broken by flexure have long been employed for homogeneity tests and the examination of fibrous structure, and of late years such bars are used in the study of brittleness.

Of all the tests for brittleness that of bending a bar under impact is the oldest. This is called the cold-bend test when done by repeated blows of a hammer, and it is well known that it gives an excellent idea of the quality of the material as respects ultimate strength and elongation. This method has been used on nicked bars by several of the authors of the papers in this volume, apparatus being devised to measure and record the work expended. Fremont and Le Blanc used a falling ram, Charpy a swinging pendulum, and Guillery a revolving wheel carrying a hammer. Fully as important as the work of rupture is the angle made by the two parts of the bar at the time of rupture, and when the tests are made on bars of the same size this angle appears to be proportional to the work. In these tests the shape and depth of the nicks or notches was found to have much influence upon the results. It was seen, for instance, that with soft steel the fracture was fibrous for a rectangular notch and granular for a triangular one. No standard form of nicking has yet been established, and there appear to be no theoretic reasons why a triangular or semi-cylindrical notch is preferable to a rectangular one. As for the depth of the notch it should be a definite proportion of the thickness of the bar and probably one-fourth of the thickness is a good depth.

The above is a summary of the most important points in the introductory essay of Le Chatelier. To summarize even the most important of the thirty papers in the volume is not possible within the limits of a review. While these papers contain very valuable matter, it may be noted that much yet remains to be done on the subject of brittleness. Especially it seems desirable that the relation of brittleness to modulus of elasticity, elastic limit, yield point, ultimate strength, ultimate elongation, and contraction of area, as observed in a common tensile test, should receive further study. In a rough general way the effect of each of these quantities upon brittleness and toughness is known, but the formulation of their combined effect has not yet been made. The problem will probably prove to be so difficult that the quantities determined in a static test are not sufficient, but one or more elements derived from an impact test will be necessary for its solution. The full understanding of the causes of brittleness is certainly of great importance, as shown by the facts that this volume is issued by the French Society for the Encouragement of Industry and that the six great railway companies of France have defrayed a large part of the expense of its publication.

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STRENGTH OF BEAMS, FLOORS AND ROOFS.—Including Directions for Designing and Details of Roof Trusses, with Criticism of Various Forms of Timber Construction. Prepared Especially for Carpenters and Builders. By Frank E. Kidder, Author of "Architect's and Builder's Pocket Book," "Building Construction and Superintendence," and "Churches and Chapels." New York: David Williams Co. 5½ × 8¼ ins.; pp. 222; 168 figures in the text and 21 tables. $2.

The house carpenter is the man addressed by this ably written little book. The title might be put: "How to Design and Figure Wooden Beams and Trusses; for the Practical Builder," and it would then characterize fairly well the contents of the work. Other features of wooden framing than purely beams and trusses are discussed somewhat: joints in framing, the arrangement of wind-bracing, and some other details, all of which are immediately connected with the subject of wood framing. In the last third of the book numerous questions and answers concerning the suitability or sufficiency of different wooden roof trusses, etc., which were either proposed or actually built, are given, these being reprinted from the correspondence columns of "Carpentry and Building." The replies were contributed by the author. This portion of the book may have interest for some engineers, as it illustrates a number of wooden roofs that are shocking in their disregard of structural principles; some of these roofs were actually built, before better advice made itself felt. It is true, however, and unfortunately true, that worse examples may be found than any shown in this book. Churches and assembly halls seem to be favorite places for perpetrating constructions of that sort. Matter of the kind contained in the present book has value as a contribution to public safety against the practical carpenter's structural work as too frequently found.

MECHANICAL DRAWING.—Technique and Working Methods for Technical Students. By Charles L. Adams, Associate Professor of Drawing and Descriptive Geometry in the Massachusetts Institute of Technology. Boston: Geo. H. Ellis Co. Cloth; 8½ × 11¼ ins.; pp. 204; 23 plates, and 160 figures in the text. $3.

This book has been prepared for use in the first year courses in drawing and descriptive geometry in the Massachusetts Institute of Technology. It presents a collection of material sufficient "to enable the teacher, by judicious selection, to lay out the work of a course, whether designed solely for educational training, or as an introduction to a practical course in engineering or architecture, or for a further specialization to meet the need of individual students." After taking up drawing instruments the author treats of conventional signs, lettering and working methods, geometrical construction, object drawing and working drawings. He then considers "pseudo-pictorial representation," isometric and wash drawing. The concluding chapter takes up the subjects of mechanical copying, the blue-print process, process drawing and patent office drawing. Though somewhat lengthy at times, the text is comprehensive, and it is lucidly written. The illustrations are numerous and they are as a rule good and well reproduced. It seems a mistake to scatter the full-page plates somewhat promiscuously throughout the work, instead of placing them always, as they sometimes are, opposite the corresponding text or else bringing them all together at the end of the book. On the whole, however, the book is an unsually good work on mechanical drawing.

THE COPPER HANDBOOK.—A Manual of the Copper Industry of the World. Vol. V., for the Year 1904. Compiled and Published by Horace J. Stevens, Houghton, Mich. Cloth; 6 × 9 ins.; pp. 882. $5; full morocco, $7.50.

The fourth edition of this valuable reference book was reviewed in these columns, June 16, 1904. In that edition there were described 3,311 copper mines. This new edition contains a list of 3,849 copper mines, with from two lines to 14 pages devoted to each mine. The names of the mine officers, the capitalization of the company, the annual output of the mine, the number of men employed, the mining plant equipment, the amount of development work done, the milling and smelting plant, and all other essential details are given with regard to each copper mine in the world.

This book serves the purpose of a reference book on all the copper mines and copper deposits in all countries, and it furnishes also an excellent mailing list for manufacturers of mining machinery and supplies.

A Text-Book of Civil Engineering.

Reviewed by A. N. Talbot.*

CIVIL ENGINEERING.—A Text-Book for a Short Course By Lieut.-Col. G. J. Fiebeger, M. Am. Soc. C. E., Professor of Engineering, U. S. Military Academy. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 573; 180 figures in the text. $5, net.

The author states that this book is designed primarily for the cadets of the U. S. Military Academy, who are being fitted for a profession in which the principles of civil engineering are of daily application. The aim of the short course in civil engineering which is given at the Academy is to teach the cadets the general principles governing the construction of engineering structures, having in mind the civil engineering work which the officer may meet and also the principles of civil engineering which may be applicable in military engineering. The field which the term civil engineering is intended to cover and the relative importance attached to the parts may be seen from the following grouping of the contents of the book: mechanics of materials, including beams and columns, 157 pages; materials of engineering, including timber, metals, stone, cement, and concrete, 61 pages; bridge analysis, design, and description, 141 pages; masonry dams, retaining walls, arches, and foundations, 141 pages; highways, 38 pages; hydraulics, 34 pages; water supply, 23 pages; sewerage, 22 pages.

Before examining the contents of the volume, as just outlined, some general comments on engineering instruction may not be out of place.

In discussions of educational methods it is generally recognized that the aim of engineering education should be the teaching of general principles. At the same time, it is well not to confuse principles with generalities. Mere general statements and dogmatic assertions of truths will not suffice. Besides, the presentation of general principles is of little value unless the mind comprehends and appreciates these principles. To be understood, the principles must seem concrete to the student and he must feel that he grasps their significance. Those engineering topics which are capable of complete mathematical analysis and calculation lend themseles most readily to the presentation of underlying principles. Definiteness of statement, mastery of argument, and opportunity to make direct application in mathematical form appeal to both student and instructor. Mechanics of materials and bridge analysis are good examples of branches which may thus be presented to the student. Other branches in which this form of analysis is not so prominent are more difficult to present. To develop engineering sense in a way to start engineering experience, and to awaken the student to the difficulties, uncertainties, and variations involved in engineering construction (particularly in many of the forms known as civil engineering construction) is a more difficult pedagogic problem, but not an unimportant one. It is not engineering information, details of practice or general descriptions of engineering works which are of most value to the student, but the development of proper habits of thought and the establishment of a right point of view, and such training requires skillful presentation. Topics which are not susceptible of much mathematical analysis form an important element in engineering education, but reasoning, discussions, statement of practice, must be made with an eye to the effect on the training and development of the student. Books which give engineering information clearly and specifically but dogmatically may not be judicious text-books for the immature student. Schools having a preponderance of studies involving mathematical analysis have been criticized as turning out mere mathematical experts whose tendency is to carry calculations to useless refinements and to apply mathematical analysis in extreme or absurd ways. On the other hand, schools emphasizing so-called professional subjects may attempt to provide engineering information, details of practice, etc., without developing and training the student along right lines. Yet the briefer the course in a given subject is, the more likely it will deteriorate into information-getting or into mere generalities and popular statements of engineering practice. To distribute the time available for instruction among the various subjects so as to train sufficiently in mathematical and analytical method and at the same time develop the engineering instinct and habit of thought, and to present the non-mathematical portion in such a way that principles rather than information will be emphasized is a complicated problem whose solution is bound up with the conditions surrounding the individual institution.

The author of this book seems to have solved the problem of division of space and manner of presentation of matter, on the whole, very satisfactorily. In making the distribution of material among the subjects treated it is to be presumed that the author had in mind not only the relative usefulness of these topics to the army officer, but in perhaps greater degree the educational value and training to the cadet. The definiteness of mathematical treatment appeals to the student in his stage of mental development and lack of engineering experience, and lack of familiarity with the objects of engineering design make the discussion and presentation of many engineering principles which do not permit mathematical statement less satisfactory to him, particularly in a brief course. The division of space is in keeping with this idea, and the parts involving mathematical analysis occupy the larger part of the book. It is also true that this analytical work is the strongest part of the book and is generally to be commended for its clearness, directness, and freedom from unnecessary mathematical complexity. The descriptive portions are also clear and generally definite, but the purpose seems too often to be to convey information, sometimes in an encyclopedic manner, sometimes by more popular method, sometimes so briefly as to be almost meaningless.

The treatment of the mechanics of materials is as complete as necessary; in fact it covers most of the ground given in many text-books on this subject. The presentation is quite satisfactory. The analytical and graphical determination of stresses in trusses is given fully enough for the student to be able to calculate stresses in bridge members. Nothing is given on details and connections except a little on rivets and pins, the treatment being limited to the mathematical determination of stresses in the truss members. Masonry dams and retaining walls and masonry arches are treated in sufficient detail for the purpose. The chapter on timber is largely descriptive, but the two pages of mechanical properties of wood give breaking and working stresses. The chapter on metals is less satisfactory. Instead of basing the classification of iron and steel on methods of manufacture and properties, it is based upon the percentage of carbon. The student is left to understand that in both the Bessemer and the open-hearth process of making steel the operation consists in merely mixing melted pig iron with the proper amount of oxide of iron, etc., to secure the proper composition, and no hint is given that the carbon, silicon and other ingredients are burned out or otherwise removed. Although mention is made of structural steel only, the process of hardening and tempering steel is described without a limiting statement. Values are given for breaking unit stresses and the amount of elongation in 8 ins. is stated, but there is no reference to the dimensions of the test piece to which these values apply. In fact there is no discussion of test pieces and methods of making tests, which omission is evidently an oversight. It is stated that red-shortness and cold-shortness are to be avoided by fulfilling chemical requirements, and there is no reference to the detection of these defects by surface appearance or by the cold bend test. The citation of specifications for material for the suspension bridge is given as though this were representative material.

The few pages on cement, mortar and concrete give altogether too meager a treatment. It would seem that the military engineer should be well versed in the proportions, requirements, and tests for cements, mortars, and concrete. The chapter on masonry is made up largely of definitions and general description. The chapter on highways is largely descriptive, but the reader is given good information on the various forms of pavement. The pressure and flow of water is fairly well treated, though the application to pipes and conduits could be bettered. If one is to judge from the needs in army posts and camps and from the possibilities of work of the army in our more distant possessions, the space given to water supply and sewerage is meager. Aside from semi-popular decriptions of water filters and sewage disposal methods and general statements applicable to large systems, there is not much of value. Less than three pages are devoted to the distribution system of water-works. The eight pages given to sewers have for illustrations a pipe sewer joint and a form of large sewer probably used in but one place in this country, and the one reference to limiting velocity in sewers recommends 2½ ft. per sec. for the minimum limit and 4 ft. per sec. for the maximum limit, without a further word of explanation. These chapters might have been made of considerable educational value as well as of greater professional advantage.

The book has a good index, but there are far too few cross references in the text. A few variations from general engineering usage may be noted, like modulus of crushing instead of ultimate strength, and the distinction between bridge and viaduct is based upon the presence or absence of water rather than upon form of structure. The values given for safe practice have no definite statement of the conditions for which they are recommended.

On the whole the book is a worthy successor of Mahan's Civil Engineering and of Wheeler's Civil Engineering so long used at West Point. It covers the essentials of the subject clearly and fairly well. The methods of presentation are generally in keeping with those of the engineering colleges of the country. Parts of the book may be useful to students in other lines of engineering who desire some knowledge of civil engineering branches.

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A Handbook of Testing Alternating Current Machinery, Chiefly for Laboratory Use.

Reviewed by H. H. Norris.*

PRACTICAL ALTERNATING CURRENTS AND ALTERNATING CURRENT TESTING.—By Charles F. Smith, Assoc. M. Inst. C. E., A. M. I. E. E., Whit. Schol. Manchester, England: The Scientific Publishing Co. Cloth; 5½ × 8¼ ins.; pp. 437; 204 figures in the text. 6s., net; American price, $2.40.

As the name implies, this work is primarily a laboratory hand-book, but the author has endeavored to broaden its field of usefulness by giving introductory explanatory matter before the laboratory instructions, which cover the testing of different classes of alternating current machinery. The result is a book which will be useful to students as a guide in performing experiments and in making deductions from the data thus gained, and it will also be helpful to persons who have a practical knowledge of the machines treated and who wish to understand the theory underlying their performance.

The material may be roughly divided into two parts, one treating of the fundamental laws of single and polyphase circuits, the other dealing with the several classes of electrical devices. The latter, in the order treated, are: transformers, alternators, synchronous motors, rotary converters and induction motors. This arrangement is logical and the selection of typical machines is satisfactory. The series of 53 experiments is designed to familiarize the student or reader with the characteristic features of operation of a large number of machines. The experiments appear to be all interesting and practical, but a smaller, well-selected list would have been less confusing and would have conveyed just as clear an impression of the subject.

In approaching each section of the subject the author first covers briefly the theory of operation of the type of machine to be studied. The statements are illustrated by brief, simple algebraic proofs and by numerous conventional diagrams. Then follow laboratory instructions covering several typical experiments, each preceded by a clear diagram of the electrical connections. A log blank is given for systematically recording the data, and curves are presented to show in a general way what results are to be expected.

The book closes with a mathematical chapter on the analysis of periodic curves, a subject of importance to investigators who desire to utilize to the greatest extent the results of the experiments described in the book.

While the book contains no new features of material or arrangement, as a whole it is well written and apparently covers its intended field. For the price it is remarkably well printed and bound.

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British Books on Steam Engineering.

Reviewed by Storm Bull.*

STEAM ENGINEERING.—A Treatise on Boilers, Steam, Gas and Oil Engines, and Supplementary Machinery, with Instructions for Carrying out Numerous Simple Experiments Adapted for the Use of Elementary Students in Technical Schools and Science Classes. Second Edition, revised and greatly enlarged. By W. W. F. Pullen, M. Inst. M. E., Assoc. M. Inst. C. E., Author of "Experimental Engineering," "Combustion of Fuel," "Indicator Diagrams," etc. Manchester, England: The Scientific Publishing Co. Cloth; 5¼ × 8¾ ins.; pp. 454; 454 figures, mostly in the text. 4s., net; American price, $1.60.

COMMERCIAL ECONOMY IN STEAM AND OTHER THERMAL POWER PLANTS.—As Dependent upon Physical Efficiency, Capital Charges and Working Costs. By Robert H. Smith, Assoc. M. Inst. Mech. E., M. Inst. E. E., Professor Emeritus of Engineering in the Birmingham University [Birmingham, England]. With Numerous Diagrams by H. Malcolm Hodson, Assoc. M. Inst. Mech. E. London: A. Constable & Co. Philadelphia: J. B. Lippincott Co. $7, net.

Pullen's "Steam Engineering" is purely elementary in its character, which fact ought to have been brought out in its title. It is also a conglomeration of various things which one does not expect to find in a book of this kind. The author attempts to teach the designing and testing of boilers and also of the various heat motors with their auxiliaries. When to this is added that he also gives a short synopsis of mechanics and of elementary thermodynamics it must be admitted that he attempts to cover a very wide field. A knowledge of elementary mathematics only is presupposed and in consequence the author can only impart an elementary knowledge of a number of the subjects treated. Like a great many British authors, he treats his subject in a very empirical manner, even too much so for most Americans. But on the other hand he is very concise, and in general his explanations and comments are very much to the point. The reviewer has found a number of crudities in the book, among others the following explanation of how the steam works in the de Laval steam turbine; "steam impinges on vanes, and the resulting impact turns the vanes and the wheel around." Such an explanation may be due to carelessness, as the author ought to know that the first requirement for an efficient turbine, whether steam or water, is that there must be no impact.

A very large part of the book is taken up by descriptive matter in connection with the large number of illustrations of boilers, engines and their parts. Being an elementary book this was inevitable, but the volume contains also a very large number of carefully worked out examples of the design and of the testing of the various boilers and engines. The reviewer is of the opinion that a book of this kind would be very serviceable, not alone for the ordinary mechanic, but also for use in the summer schools for mechanics of which so many have been started in the last few years.

This being a book published in England it was only to be expected that the illustrations and examples would be principally taken from British practice; and necessarily this fact diminishes its usefulness in this country. But taking it altogether, the opinion of the reviewer is that the book is better than most of its class, especially as the illustrations in general are very good and because the price is very moderate.

The second book to be reviewed under this head is of a totally different character from the preceding: if the latter deserved to be called elementary, Smith's book surely ought to rank among the most advanced books of its class. As is implied in the title, it treats of the commercial economy of the various types of power plant in which heat energy is utilized, and the attempt is made to establish the economy on both a rational and scientific basis. The introductory chapter of nearly 50 pages is a very thorough discussion of what is meant by "profit" and by economy of a plant, and a study of the elements that must be taken into consideration. A large part of this chapter might seem to have been intended for some treatise on political economy, except that perhaps the engineering knowledge of the author always is apparent. But it makes difficult reading, both because of the extreme conciseness of the author, at many points, and because of the many uncommon or wholly new words which he uses. This latter peculiarity is still more apparent in several of the later chapters, in which the author has coined new words such as "kinetic and resilient transpowers," "dynothermic coefficient," and "stress specific heat," to mention only a very few. These terms may be very expressive, but to an ordinary reader—of the engineering profession—they will sound very strange. It would almost seem that the author has tried as much as possible to get along without using the ordinary terms; for instance, he never uses the word "expansion" in connection with steam, but speaks of stress and strain in connection with the internal changes taking place in the steam when it is being used in the cylinder. The probability is, however, that the author is so thoroughly imbued with the principles and expressions of pure mechanics and physics that he could not help using the same terms in a book written evidently for the practising engineer. It is therefore the opinion of the reviewer that the book never will be used by the class of people for which it was intended, as these will not find the necessary time to digest a book of this character. The reviewer may, of course, be mistaken in this; but he personally has found a great many works on higher mathematics easier reading than Smith's book.

In apparent contradiction to the previous judgment is the statement made earlier in this review that the engineering knowledge of the author is apparent everywhere. The trouble is, however, that he clothes this knowledge in such strange garments that it will not always be readily recognized as such. Nevertheless one cannot go far in the study of this before it will be apparent that the author has had clearly in mind what he wanted to do, and that he has something really important to say. How the various factors enter into the computation of the economy of a plant he discusses very thoroughly. He shows, for instance, how by means of differential calculus, or preferably by graphical methods, the maximum economy may be obtained, when (as always) there are a number of variables, or, reversing the problem, how these various variables must be selected in order to produce a certain maximum economy. The author has found a very interesting problem in the inter-relation between size and cost of boiler, temperature of furnace and chimney, rate of running boiler, and economy of the plant. This is picked out as one out of a large number of equally interesting problems relating to boilers and engines which the author analyzes, so that notwithstanding the previous criticisms the book is one of great merit.

The tables and diagrams contained in the book represent a very large amount of work. A number of them are extremely interesting, as for instance: diagrams giving the various properties of steam, the variables being respectively pressure, temperature, volume and entropy; another set of diagrams giving the prices of the various classes of engines in terms of steam pressure, piston speed, horse power, etc., these prices being based on information gathered from manufacturers; still another set of diagrams giving the total cost of complete power plants, depending on what kind of steam engine is used, or whether it be a gas or a Diesel engine, and on what kind of boiler is installed; and finally a set of diagrams giving the annual cost of these plants. It is true that the prices in these diagrams are all taken from Great Britain, but it is probable that there is almost a constant ratio between these and the corresponding ones in the United States so that the diagrams even with their English origin should be found very useful.

The book presents a very fine appearance, the paper and typographical execution being excellent.

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GERMAN TECHNICAL WORDS AND PHRASES.—An English-German and German-English Dictionary of Technical and Business Terms and Phrases Used in Commerce, Arts, Sciences, Professions and Trades. With Appendix of Tables of Money, Weights and Measures. With the New German Orthography. By C. A. Thimm, F. R. G. S., and W. von Knoblauch. London: E. Marlborough & Co. Cloth or leather; 3 × 5½ ins.; pp. 218. Cloth, 2s. 6d.; leather, 3s. 6d. American price, $1 or $1.40.

Within its limited scope this dictionary is serviceable, but it is hard to account for some of the omissions. Since the volume is too large for the vest pocket, a wider page might well have been used, and the dictionary thus been made thinner, or better yet, the number of entries might have been increased. There are no definitions in either language; merely an attempt at word-equivalents.

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McGraw Publishing Co.
Publishers, Importers and Booksellers,
Engineering Building. 114 Liberty Street, New York

English Street Railways.

PERMANENT WAY FOR TRAMWAYS AND STREET RAILWAYS.—By Thomas Arnall, Assoc. M. Inst. C. E. London, England: The Railway Engineer. Cloth; 7½ × 10 ins.; pp. 246; 233 cuts in the text. 12s. 6d. (by post 13s.). American price, $5.

The construction of street railways is a field which has been opened to American engineers within comparatively recent years, a majority of the earlier work of this kind having been mainly in the hands of foremen and contractors. In England, however, this work has always been the engineer's field, and is as much a branch of engineering as the construction of steam railways, sewers, or water-works. From the very beginning, too, the street railway (like the steam railway) has been under government supervision, through the agency of the Board of Trade. Every proposed line must first be submitted to and approved by the authorities; while its construction, equipment (and to some extent its operation) are all subject to the same supervision. For example, the general route and the track or permanent way construction must be approved in detail, and the width of cars must be such as to give a minimum clearance for cars passing each other on curves. In the book before us these government regulations are dealt with at some length, but they are of only very general interest in this country. With the steady improvement in American street railway construction, however, it is of some special interest to study the features of English practice; and these are fairly well presented. The book deals only with recent practice, and does not enter into the earlier systems or the development of the present system. It is also limited, as far as track construction is concerned, to lines in city streets, and does not take up country or interurban electric railways, although in England these are classed as "tramways."

The first chapter deals with the rules and regulations of the Board of Trade (under the Tramways Act of 1870) concerning construction and maintenance; and one may imagine the feelings of the engineer (and the president and manager) of a new street railway company in this country if required to submit to a government board a map of the line and drawings of its track construction, switches, rail section, cars, etc., as a necessary preliminary to being granted even permission to build the road. The conditions imposed were very stringent, but have been evaded in many cases owing to the greater freedom allowed under the Light Railways Act (1896):

> More than half of the light railways that have been promoted or authorized since the Act (1896) came into force have been street or road tramways in all essential particulars; but their construction as tramways would have been quite impossible in many cases owing to the expense involved in carrying out the conditions imposed by the older acts and precedents.

With so much space devoted to regulation by the general government, it is strange that there should be nothing said as to the relations between street railway companies and municipal authorities. This omission will be somewhat of a disappointment to American readers.

In dealing with the construction work, the author begins with the concrete foundation, and it is rather surprising to find him stating that this is really required only on account of the paving, and that the track would be better if the rails were supported on timber ties. Nothing is said as to the form and preparation of the subgrade, or the thickness of the concrete (whether uniform or increased under the rails), although these are very important matters. Only hand mixing of concrete is mentioned. Under the head of paving, the space is devoted entirely to stone and wood blocks; brick is not mentioned, and asphalt and macadam are said to be so little used as not to call for notice. It would appear that under the strict regulations as to maintenance of the streets, English street railways find it difficult and expensive to keep stone block paving in good condition. Soft wood (pine or spruce) is not recommended for heavy traffic, as it wears unevenly; and as the life is limited by wear rather than decay the cost of creosoting under pressure is not advisable, although the blocks may be dipped in creosote oil to prevent decay while in storage. The principal hard woods used are the Australian jarrah or karri. In laying the pavement, each block is usually dipped (bottom only or bottom and one side) in a hot bituminous composition (in portable melting pots) just before it is placed in position. The same composition is afterwards flushed over the surface to fill the joints, although the author considers that cement grout would be better for this purpose, as it would facilitate removal for repairs. A thickness of 4 ins. for hard wood blocks and 5 ins. for soft wood blocks is recommended.

The numerous designs of rails and rail supports formerly used are not described, as it is pointed out that they have given place to the grooved girder type, standard sections and specifications for which have been prepared by the British Engineering Standards Committee. There is no mention of tee-rail construction, even for country lines. The Board of Trade rules limit the width of groove to 1⅛ ins., except on sharp curves, and this is adopted in the standard sections. The illustrations, however, show rails with grooves from ⅞-in. to 1¼ ins. in width, and the same range in depth. It is stated that the lip should be ¼-in. lower than the head, and that a wear of ½-in. in depth of head should be allowed. The carbon content of the rail steel varies from 0.40 to 0.65%, and the requirements for these deep and heavy rails on continuous supports are different in many respects from those for ordinary railway rails.

The rail-joint question is discussed at some length, but in regard to the expansion spacing the author does not appear to recognize the insulation or protection of the rail by the paving in which it is embedded. He considers the rail ends as cantilevers, on the ground that an absolutely continuous bearing on the concrete does not exist. Most of the rails illustrated have only one row of bolts, and the author advocates a length of 4 ft. for plain splice bars and 2 ft. for angle bars. A variety of joints are illustrated, some of these having base plates or heavy bars under the rails, or anchors embedded in the concrete. Cast, electric and thermit welding to make continuous rails are discussed, but the continuous rail is not approved. Unfortunately nothing is said as to the extent to which the various joint appliances or welding processes have been used, or what results have been obtained in service. Tie-bars, whether attached to the web or base of the rail, are believed to have little influence in maintaining the rails in position after the track has been completed and paved.

In discussing switch construction, the opinion is expressed that the conditions to be considered will be cars with rigid wheelbase and high speed, rather than double truck cars at slower speeds. An American tongue switch is shown, and several patented switches for grooved rails. The use of manganese-steel for switches, frogs, etc., is referred to as a notable feature in recent construction. Frogs built up of rails are not adapted for street railway track, and steel castings are commonly used, some of these having renewable blocks for the wearing parts. Some very complicated examples of special work for junctions and crossings at city street intersections are illustrated, and it is recommended that such work should be erected complete at the factory, to ensure its going together properly in the track, so that the work will interfere with street traffic for as short a time as possible. Some plans of connections to car sheds are also shown.

A special chapter deals with the transition treatment of the sharp curves required on street railways, and this is specially necessary where four-wheel cars are operated. The parabola, cubic parabola, sine and lemniscata curves for this purpose are considered mathematically, but no instances of their use or application are given, and nothing is said as to the field work or the curving of the rails. Other chapters deal with (1) temporary tracks for use when a portion of the line is under repair; (2) with sewer connections for draining the track and street (and having openings in or beside the rails), and (3) with traversing tables for use in car sheds; the table runs on surface rails and not in a pit like a transfer table. The chapter on tools is unsatisfactory. It gives a list of tool equipment, but for what number of men is not stated; and it describes simply rail drills, saws and benders (including some familiar American tools). Methods of bonding the rails and the necessity for effective bonding are discussed in a separate chapter. Several styles of bonds are shown and the welding of rails is mentioned, but nothing is said as to the efficiency of or experience with these bonds.

Conduit construction for cable and electric railways is the subject of the last chapter. For electric traction, a side slot (serving as the groove of the rail) may be used, and has the advantage of eliminating the center slot and its rails, which interfere with the horses and break up the continuity of the paving. There are objectionable features, however, and the author states that "it is still a debatable matter as to which type of construction has the balance of advantage." The characteristic feature of American conduit construction is said to be the use of massive iron yokes with extensions to carry the track rails, but in England the conduit is generally quite independent of the rails, and the long yokes have only been used in a few cases. Several English conduit systems are described and illustrated, including their switches, frogs and crossings.

The Tramways Act, Light Railways Act, Board of Trade Rules and other similar matter are given in full in the appendices. The new regulations for guard wires to prevent telegraph or telephone wires from falling upon the trolley wires are included, but the book does not attempt to take up the electrical work or equipment of street railways.

The book will be of use to American engineers mainly in enabling them to inform themselves as to the conditions under which street railways are built in England (except as to conditions imposed by the municipalities), and as to the general character of English practice in construction. There are, however, many important points that are omitted entirely, or treated too briefly. For instance, nothing is said as to the organization for a method of carrying out the actual work of construction and maintenance. The style is also somewhat too general, there being nothing to show the practice as to complete track construction and equipment of lines in individual cities. In spite of its somewhat numerous limitations, however, the book is a welcome addition to a branch of technical literature that has not yet been thoroughly or effectively covered.

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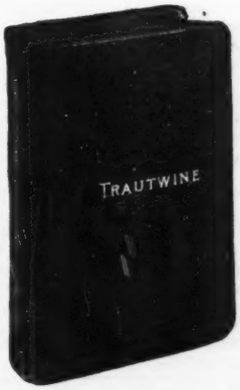

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JOHN WILEY & SONS
Scientific Publishers
43 and 45 East Nineteenth Street
NEW YORK CITY

A French Style of Highway Bridges.

Reviewed by Mansfield Merriman.*

RECUEIL DE TYPES DE PONTS POUR ROUTES.—By Maurice Koechlin, Administrateur-Directeur de la Société de Construction de Levallois-Perret. In Encyclopédie des Travaux Publics, begun by C. Lechalas. Paris, France: Ch. Béranger. Paper; 6½ x 10 ins.; pp. 306; many tables and 104 figures in the text. With atlas of folding plates, 10¼ x 12½ ins.

This work gives computations and drawings of the highway bridges constructed by the Levallois-Perret Co., the length of span ranging from 4 to 30 m., and all having solid floors. The spans of 4, 8, and 10 m. have deck plate girders, while for longer spans pony lattice girders are used. For the span of 30 m. a buckle-plate floor is shown, but for spans of 25 m. and less brick arches are employed. All of the designs provide two sidewalks 75 cm. in clear width, some having a roadway 5 m. wide while others have only half this width, and in no case is provision made for trolley tracks. It is difficult for an American engineer to imagine what circumstances would justify the construction of a solid-floor highway bridge having a roadway only 8¼ ft. in width, but evidently there is a demand in France for such structures.

The design presented for a bridge of 15.7 m. span, with a 5 m. roadway and two sidewalks, shows two lattice girders 6.85 m. c. to c. These girders are 2 m. deep and have a quadruple Warren system of webbing formed by plates 9 mm. thick and of different widths up to 15 cm. At intervals of 1.57 m. there are vertical stiffeners or posts formed of angles, and to these the floor beams are attached. The flanges are made of angles and plates and a central web about 40 cm. deep, and to this web the diagonal members and vertical stiffeners are riveted. The floor beams are plate girders about 65 cm. deep and their lower flanges support brick arches 11 cm. thick, which have a clear span of 1.1 m. and a rise of 40 cm. Above the arches is concrete filling which has a depth of 20 cm. above the crown, and above this is ballast 15 cm. deep. Steel rods connecting the tops of the floor beams are fastened to iron keys at the crown of the arch. This is certainly a very stiff structure, and its weight is 26,550 kilograms of metal, plus 128,000 kgr. of brick and concrete; this gives 6,600 lbs. per lin. ft. for the dead load, or 1,130 lbs. per lin. ft. for the weight of the metal alone.

The volume of text contains methods for computing the bending moments and stresses and for designing the members, these being given without any theoretical explanation. The live load is taken as 400 kg. per sq. m. (82 lbs. per sq. ft.) on the sidewalks, while wagons weighing 11,000 kg. cover the roadway. The method used for computing a plate-girder is the same as that for a solid rolled beam, the flange stresses being determined from the moment of inertia, and the shearing stress in the web from the formula for shear at the neutral surface. The shearing stresses on flange rivets are found from the same formula, using the moment of inertia and the statical moment of the flanges. This method is undoubtedly more theoretically correct than that in common use in this country, which supposes the shear to be uniformly distributed over the vertical section of the web. The author refers constantly to Henry's Formulas and Tables for his equations, even in such a simple matter as computing the bending moment on a floor beam. The book is admirably adapted to the use of those who desire to design this style of highway structures without thinking of the theory of the subject, for they can scarcely go astray when the length of span is less than 90 ft. To American engineers the book is only valuable as a curiosity, for according to American ideas it shows how a bridge ought not to be built.

THE SOUTH AFRICAN ARCHITECT & BUILDER.—A Journal devoted to Architecture, Building, Brickmaking, Engineering, Electricity, Real Estate, and all matters associated therewith. Vol. II., No. 20, May, 1905. Cape Town, South Africa: (P. O. Box 523). Paper; 8½ x 10¾ ins.; pp. 151 to 172. 6d.; 7s. 6d. per year.

Engineers and architects in South Africa and those elsewhere who wish first hand information from that part of the world are likely to be interested in this journal. Its publication was begun a few months ago, but this is the first number that has come to our attention.

*Professor of Civil Engineering, Lehigh University, South Bethlehem, Pa.

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Publisher and Bookseller **MYRON C. CLARK** 21 Park Row, New York

Geodetic Astronomy for Civil Engineers.

Reviewed by Hector C. Hughes.*

THE ELEMENTS OF GEODETIC ASTRONOMY.—For Civil Engineers. By H. C. Lord, Professor of Astronomy at the Ohio State University and Director of the Emerson McMillin Observatory. Columbus, O.: (The Author). Cloth; 5 × 7¼ ins.; pp. 136; 17 figures in the text. $1.50 net.

The study of astronomy by the student of engineering is properly of a practical nature. The determinations of azimuth, latitude, longitude and time, the problems with which he is chiefly concerned, are usually taught as part of a course in surveying. The utmost that can be hoped for in such a place is to teach him to make the observations and reductions with intelligence and accuracy. Most of the text books on surveying treat the subject with so little explanation of astronomical phenomena that the results of the teachings often fall short of the least that is desired.

Professor Lord has given in a small volume an exposition of his subject which in many respects fills the gap between the surveying text book and the more extended treatises suitable only for specialists in Geodetic work. His explanations of the necessary astronomical laws are concise and clear in all but a few important details, where the reader unexpectedly becomes bewildered. His instructions for making observations are plain and consecutive. The chapter on the sextant is unusually good. Though the formulas for reducing observations are stated in a manner intended to lessen labor, yet they are in many cases formidable. One formula depends upon another, and its terms are expressed by letters previously explained. Considerable effort is often needed to find what one is seeking.

More precision is presupposed than is required for observations usually made by the engineer, whose instrument is a portable transit, and neither a theodolite nor an astronomical transit. The author apparently expects the student to spend much more time on this subject than is usually available in a technical course. The reviewer thinks that the book is beyond the needs of the ordinary engineering student, and that its weakness is aptly expressed in the author's own words in the preface to the book—"He is firmly convinced of the value of this subject as a training for the young engineer. Practical astronomy gives as nothing else does experience in precise measurement and handling long and intricate calculations."

Practical Hygiene.

A MANUAL OF PRACTICAL HYGIENE.—For Students, Physicians and Medical Officers. By Charles Harrington, M. D., Assistant Professor of Hygiene in the Medical School of Harvard University. Third Edition, Revised and Enlarged. Philadelphia and New York: Lea Brothers & Co. Cloth; 6 × 9½ ins.; pp. 793; 12 plates and 118 figures in the text. $4.25.

In reviewing the second edition of this book (Sept. 17, 1903) we said that it deserved a "high rank among general treatises on hygiene." The demand for a third edition within some four years indicates that the book has been appreciated. In the second edition there were about 70 pages of new matter and some 30 pages of old matter was considered obsolete and cut out. Additions to and omissions from the present edition result in a net gain of 30 pages. A new chapter on "Infection, Susceptibility and Immunity" reviews the immunity theories of Ehrlich and Metschnikoff and gives some of the practical results of the immunity studies, the most brilliant, in fact the "only really brilliant," of which are related to diphtheria and lie in the use of antitoxin. It must be remembered, however, that the practical phases of these studies are of recent development and "that the problems of biochemistry are exceedingly complex."

Little if any change seems to have been made in the chapter on sewage disposal, and the chapter on garbage disposal remains the same as in the second edition. The Jones fume cremator is now of historic interest, merely. The statistics of garbage incinerating plants in Great Britain and the United States are still given as for the year 1899, whereas much later figures for each country are readily available. Other defects of this particular chapter, noted in our review of the second edition, still remain. These are minor matters, as compared with the general excellence of the book, but they throw possible light on the thoroughness of the revision of other portions of the book. Nevertheless, the volume still maintains its lead among American books on Hygiene.

*Assistant Professor, Division of Engineering, Harvard University, Cambridge, Mass.

BULLETINS, BUREAU OF THE CENSUS.—S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11½ ins.

No. 20: Statistics of Cities Having a Population of over 25,000, 1902 and 1903. Pp. 481; 44 tables.

No. 21: Commercial Valuation of Railway Operating Property in the United States, 1904. Pp. 88.

Some will remember the "Statistics of Cities," published for a few years by the U. S. Department of Labor before the creation of the present Department of Commerce and Labor. The bulletin before us (No. 20) is along similar lines, but embraces cities of smaller size, or all over 25,000 instead of 30,000 population in 1900. A later bulletin will cover cities of 8,000 to 25,000. The two bulletins just named will form a part of the report of the Twelfth Census. Subsequent annual bulletins will deal with cities of 30,000 and upwards. To aid in the adoption of a classification that would make the financial statistics comparable the Census Bureau has secured the cooperation of committees of the National Municipal League and other organizations interested in uniform municipal statistics.

The work reported in Bulletin 21 was begun in July, 1904. It was then proposed to ascertain the valuations placed on railway properties by State officials. This was soon found to be an impracticable method and the valuations finally made were based on the capitalization of "true net earnings" at a rate determined by the market value of the securities. The chief credit for the work is given to Prof. B. H. Meyer, of the University of Wisconsin, and to Prof. Henry C. Adams, Statistician to the Interstate Commerce Commission. The statistics in the main report are in the form of summaries by States, no railroads being mentioned. A supplement contains a number of interesting papers on the methods employed in making the valuations. Some of these papers are illustrated by statistics of a number of railways. There is a paper on foreign methods of valuing railways, and also one on railway valuation in Michigan and Wisconsin. The latter includes a quotation from a report by Prof. M. E. Cooley and another from a letter by Prof. W. D. Taylor, of the engineering departments of the University of Michigan and Wisconsin, respectively.

WATER-SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.

No. 125: Report of Progress of Stream Measurements for the Calendar Year 1904. Prepared under the direction of F. H. Newell, by R. E. Horton, N. C. Grover and John C. Hoyt. Part II.—Hudson, Passaic, Raritan and Delaware River Drainages. Pp. 114; two plates and one text figure.

No. 129: Progress of Stream Measurements, 1904. Prepared under the direction of F. H. Newell, by R. E. Horton, E. Johnson, Jr., and John C. Hoyt. Part VI.—Great Lakes and St. Lawrence River Drainage. Pp. 150; two plates and one text figure.

No. 130: Progress of Stream Measurements, 1904. Prepared under the direction of F. H. Newell, by Cyrus C. Babb and John C. Hoyt. Part VII.—Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines and Missouri River Drainages. Pp. 204; two plates and one text figure.

No. 131: Progress of Stream Measurement, 1904. Prepared under the direction of F. H. Newell, by M. C. Hinderlider and John C. Hoyt. Part VIII.—Platte, Kansas, Meramec, Arkansas and Red River Drainages. Pp. 203; two plates and one text figure.

No. 134: Progress of Stream Measurements, 1904. Prepared under the direction of F. H. Newell, by W. B. Clapp. Part XI.—The Great Basin and Pacific Ocean Drainage in California. Pp. 276; two plates and one text figure.

No. 146: Proceedings of Second Conference of Engineers of the Reclamation Service. With Accompanying Papers. Compiled by F. H. Newell, Chief Engineer. Pp. 267.

The stream measurement bulletins continue along the lines already noted for 1904 and previous years. Of the twelve numbers this year ten are already issued.

A variety of topics relating to the Reclamation Service are treated in Paper 146. These include pumping, tunneling, stream gaging, diamond drill work, training assistants, silting in reservoirs and accounting.

PROJECT FOR THE PANAMA CANAL.—By Lindon W. Bates. With General Plans and Profiles of the Waterway, the Regulation Works and the Terminal Harbors. New York: Address the Author, 111 Broadway. Cloth; 9 × 11 ins.; illustrated.

In this interesting monograph, Mr. Lindon W. Bates presents a novel project for building the Panama Canal and its terminal harbors. Mr. Bates rejects all projects contemplating the crea-

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By LIEUT.-COL. G. J. FIEBEGER, U. S. Army, Professor of Engineering, U. S. Military Academy. 8vo; xiii + 573 pages; 180 figures. Cloth, $5.00 net.

The chapters on column formulae, highways and timber are particularly good.—Railroad Gazette.

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tion of high, deep and permanent lakes; but, at both the Atlantic and Pacific ends, low-level lakes are to be formed, by broad levees connecting the hills east and west of Mindi, and by a dam across the Chagres. Tentative locations for locks, dams and levees are shown on the maps. The author discusses the regulation of the different rivers and the building of proposed dams at Gamboa and at Alhajuela.

In addition to the topographical maps there is an excellent photograph of a relief map showing the location of the proposed canal according to Mr. Bates' plan.

The Nature of Electric Actions.

ELEMENTS OF THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM.—By J. J. Thomson, Cavendish Professor of Experimental Physics in the University of Cambridge. Cambridge: The University Press. Cloth; 5 × 7½ ins.; pp. 544; 134 illustrations in the text.

The last few years' advances in our knowledge concerning, and conceptions of, electric phenomena, have given great importance to the subject of electrostatics. The prevalent philosophy of electrodynamics, that is to say of the manifestations of electric currents, seems to build up its structures of theory and hypothesis from electrostatic charge and stress. The science of the electric current—even the alternating current—and electric machinery is coming to be, if it is not even now a separate branch of electrical science, which might be called the science of practical electricity. The science of theoretical electricity, to use the symmetrically opposite term, or, to be more conventional, the science of Theoretical Physics in so far as it is concerned with electrical action, finds its working material almost wholly in electrostatics.

The utmost concession to this view characterizes the excellent text-book under notice. The book has nothing to do with what we have called the Science of Practical Electricity, and only in rudimentary form does it treat of the theory of that science. Its exclusive theme is Theoretical Electrophysics, the science whose object is to explain the ultimate nature of electric actions. Fully one-half of the book is taken up with an analysis of conditions in the electrostatic field, including a valuable chapter on the phenomena of moving electric charges, that is, minute particles of matter charged with electricity and moving at extremely high velocity through perfectly insulating space; this last chapter, which is new in the present (third) edition, is given because of the large role which charged atoms and corpuscles play in modern physics. The remaining half book treats of the magnetic field, of electric currents, and of electric-magnetic-dynamic actions. But here the magnetic field per se is given principal attention, because of its intimate analogy to the electric field, and because of the frequent coexistence of the two fields—a coexistence which is essentially concerned in nearly the whole range of electric phenomena and electrical theory.

Such a book is not written for the electrical engineer. It offers nothing that may be useful in practical application of electricity. It is written for the student and lover of pure science, a fact which the author's name on the title page indicates at first inspection of the work.

A radical distinction of this work from the ordinary treatise on pure science of the character in question is its "elementary" character. The author aimed to address not the man who is equipped with spherical harmonics and other heavy artillery of the calculus, but the many whose mathematical armament is limited to a thorough acquaintance with algebra, geometry and trigonometry. The analysis and proof, throughout the book, are carried through, without calculus, by brilliantly effective use of geometrical methods and special devices of reasoning, in conjunction with algebric procedure. At some few points, as might be expected, it was impossible to avoid calculus forms of mathematical expression; but these points will not seriously interfere with full comprehension of the main course of thought.

Books of the character of the present work have great importance and value, as they express in simplified form, hence make available to wide circles, not only the results but also the reasoning and proof of advanced thought and investigation of abstruse subjects. The general appreciation of this fact is evident from the repeated re-edition of the book. Its present edition, with the interesting added matter on moving electric charges, will doubtless even extend that appreciation. The contribution of the publishers, excellent typography and general execution, is worthy of the text.

READY OCTOBER 7th

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PUBLISHERS' NOTE

In Part I., algebraic methods have been used in all cases except for swing bridges, where the influence line method has been used entirely.

Part II., now in preparation, will treat only statically indeterminate structures, both by the algebraic method and by the modern method of influence lines.

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ELECTRICIANS' HANDY BOOK.—A Modern Work of Reference. A Compendium of Useful Data, Covering the Field of Electrical Engineering, etc., etc. By T. O'Conor Sloane, A. M., E. M., Ph. D., Author of "Arithmetic of Electricity," "Standard Electrical Dictionary," etc. New York: The Norman W. Henley Publishing Co. Leather; 4½ × 6½ ins.; pp. 761; 556 figures in the text. $3.50.

A plain, fairly concise, and well-balanced summary of practical electricity, in hand-book form, appears in this volume. The work is not a "handbook" in the more common meaning of that word, as applied to collections of data, constants, formulas and tables, with a minimum amount of text discussion; it is rather a text-book of the more common applications of electricity, written in simple style and condensed into a pocket manual. It can be strongly recommended to those having use for a book of this character. Good typography and attractive illustrations—mainly perspective line-drawings reproduced by the wax-process, in place of the muddy half-tone photographs so often found—add to its efficiency as a reference text for the electrician.

In the domain of electrical machinery, direct-current generation and distribution are fairly covered, as also the matter of operating dynamos and motors; the subjects of lamp batteries, lamps, and measuring instruments are adequately treated; telegraphy is not mentioned, no doubt intentionally; electric railways are discussed very briefly, somewhat too sketchily even for the purposes of this work. In alternating currents, generators, motors and transformers are discussed at length, though less fully than corresponding sections of direct-current working. Many accessory or special subjects, for example telephony, photometric measurement, bell wiring, laboratory measuring instruments, lighting arresters, etc., have individual chapters. In addition, there is in the first part of the book considerable matter explaining and describing electric actions, their laws, and the like, and a first chapter on mathematics, which reviews some parts of arithmetic and algebra and (strangely) contains a few words on dynamometers and on the luminiferous ether.

IMPROVEMENT, REPAIR AND MAINTENANCE OF PUBLIC HIGHWAYS.—Bulletin No. 10, Department of the State Engineer and Surveyor of the State of New York. Albany, N. Y.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 269; illustrations, folding chart and loose folding map.

Numerous recent changes in the highway laws of the State of New York have made advisable the publication of this book of instructions and suggestions. Among the changes mentioned is one placing upon the State Engineer and Surveyor the guidance of town officials in the expenditure of State and local funds raised under the Money System of road maintenance. A uniform system of town accounting of highway funds has been formulated and is set forth in this bulletin. The bulletin also contains a compilation of statistics of the cost and maintenance of highways and bridges throughout the State.

BULLETINS, FORESTRY BUREAU, U. S. DEPARTMENT OF AGRICULTURE.—Gifford Pinchot, Forester, Washington, D. C. Pub. Doc. Paper; 6 × 9 ins.

Progress of Forestry in 1904. By Quincy R. Craft. Pp. 6; illustrated.

The Attitude of Lumbermen toward Forest Fires. By E. A. Sterling. Pp. 8; illustrated.

The Determination of Timber Values. By Edward A. Braniff. Pp. 8.

Forest Preservation and National Prosperity. Pp. 31. A compendium of addresses delivered at the American Forestry Congress in January.

Reports of the Public Lands Commission. Pp. 23.

The first three of these bulletins are reprints from the "Yearbook" of the Department of Agriculture, and the report by Mr. Craft shows that at the end of 1904 the forest reserves aggregated 63,358,960 acres. The attitude of lumbermen toward forest fires is shown by Mr. Sterling to be that of indifference, while new legislation (better enforced) in regard to forest fires is desirable. The third report, by Mr. Braniff, describes experiments to determine the value of standing timber, with a number of tabulated results. The condensed addresses in the fourth publication of the above list discuss the various aspects of forestry in relation to railways, irrigation, timber supply, agriculture, commerce and manufacture. The two reports of the Public Lands Commission deal with the operation of the present laws (including timber lands) and suggested changes, and states that of the cases investigated: "almost without exception collusion or evasion of the letter and spirit of the land laws was involved." This certainly indicates that changes are necessary.

THE MINING AND QUARRY INDUSTRY OF NEW YORK STATE.—Bulletin 93, New York State Museum. By David H. Newland, State Geologist. Albany, N. Y.: Pub Doc. Paper; 6 × 9 ins.; pp. 70.

Statistics of the mineral output of New York State are given in condensed form in this bulletin. It covers the principal facts regarding the character, occurrence and production of the useful minerals, including in this term the clays and clay-products, cement, natural gas, granite, trap, etc.

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The Theory and Practice of Reinforced Concrete Construction.

CONCRETE-STEEL.—A Treatise on the Theory and Practice of Reinforced Concrete Construction. By W. Noble Twelvetrees, M. Inst. M. E., Assoc. M. Inst. C. E., Author of "Structural Iron and Steel." London: Whittaker & Co. New York: The Macmillan Co. Cloth; 5 × 7½ ins.; pp. 218; tables and 73 illustrations in the text. $1.90.

The author of this excellent little book on the theory and practice of reinforced concrete construction states that his object is to present definite and reliable information on a subject whose literature is scattered over articles in various technical journals, chiefly of foreign origin (i. e., not British). He has well carried out his avowed purpose of preserving a strict continuity of treatment, commencing with the physical properties of concrete and steel and the effect of their joint action, then discussing the principles underlying the theory of concrete-steel, following with the rules necessary for correct design and for the calculation of strength and with practical examples for each of the chief types of members employed in reinforced concrete construction. The distribution of space is well balanced. The contents of the book may be judged from the titles of the chapters: Concrete; Steel; The General Theory of Concrete-Steel Beams; The Design of Beams; Shearing Stresses in Beams; Braced Girders; Typical Forms of Beam Design; Floor Design; Working Stresses and Building Rules for Beams and Floors; Foundations; Concrete-Steel Columns.

There is no attempt to make the book a complete treatise on reinforced concrete or to give illustrative examples of the various applications to engineering construction. The attempt is rather to discuss fundamental principles in an elementary way with the expectation that sufficient foundation will be laid to enable the engineer to apply these principles to his own problems. It is not a book for the constructor who wishes to get suggestions of details of construction. The method of presentation is commendable: it is systematic, simple, clear, generally rational and sensible, and of the kind which allows the reader easily to get hold of the ideas of the author. The subject matter is not always entirely satisfactory. Being largely taken from unrelated sources, it is not strange that experimental data are not consistent. While the title page bears the imprint of 1905, the preface is not dated, and statements are made which are not now accepted by most investigators or which have more recently been repudiated by those first responsible for them. Considére's idea of concrete submitting without any rupture to a tensile distortion of twenty times that obtainable in plain concrete is given without question, as well as the statement of values for the modulus of elasticity in tension equal to one half that in compression; the use of values for the shearing strength of concrete equal to .16 to .2 of those for the compressive strength, and other unaccepted statements of properties. The resumé of the physical properties of concrete and of steel are fairly good, as is the treatment of the general theory of concrete-steel. The author's cut-and-try method of designing beams is very weak, but he betters matters later by giving the formulas of Hatt and Johnson. The chapter on shearing stresses in beams is a praiseworthy attempt to discuss this disputed question, but it can not be said that it is entirely successful. The chapter on braced girders has little of value; that on typical forms of beam design is suggestive; floor design is good, though absurdly broad compression widths of tee-beams are used. The chapter on working stresses and building rules quotes from various regulations without much comment or discussion; that on foundations contains suggestive matter, and that on columns is principally an exposition of Considére's investigations.

A commendable feature of the book is the citation of authorities and the explicit references to literature on the subject. The index is good and the cross references and well chosen titles of articles facilitate a study of the subject. As a handbook of principles the book has merit. The method of presentation is so admirable that the shortcomings of the subject matter seem the more prominent. While some of the nomenclature and methods of analysis may seem unfamiliar to American engineers, the book should be welcomed in the literature of reinforced concrete.

Wireless Telegraphy.

WIRELESS TELEGRAPHY.—Its History, Theory and Practice. By A. Frederick Collins. New York: McGraw Publishing Co. Cloth; 6 × 9½ ins.; pp. 299; 323 figures in the text. $3.

Not a few technical books have their principal value, or at least a material part of their value, in imparting to the reader's mind a broad if somewhat vague impression of the largeness and complexity of the field which they purport to discuss. In analytical as well as in descriptive treatment of their subject they are incomplete or fragmentary, sometimes for reasons that do not reflect on the author's ability; in consequence neither the advanced worker nor the elementary student of the subject finds in them the suggestion or instruction he requires, but on the other hand the general reader has spread before him an outline map of the region covered by the subject-matter of the book. Collin's "Wireless Telegraphy" is in large part a book of this kind.

We should except from this characterization, however, four chapters (about one-fourth of the book) entitled respectively "Electric Wave Detectors," "Transmitters," "Receptors," and "Aerial Wires and Earths." These chapters describe in summarized form the general nature of the various arrangements used by different inventors for the three essential parts of wireless apparatus: (1) The transmitter, containing the oscillating circuit and its accessory pieces of apparatus; (2) the receiver, composed of the wave-detector and its auxiliaries; (3) the antenna or aerial wire. The various arrangements which have been proposed or used are shown by circuit diagrams, and are described by equally sketchy text explanation. These chapters contain nearly all the "meat" of the book.

Besides these four chapters, matter of more or less importance to the practical reader is contained in the chapters "Induction Coils," "Interruptors," "Subsidiary Apparatus," "Resonance," "Syntonization," and a short chapter on "Wireless Telephony." Of these, the first two are the most complete and cogent of those mentioned. In common, however, with all the rest of the book, they give neither analytical discussion nor practical detail information, but are confined to diagrammatic description and occasional mention of some general observation on the working of the apparatus.

That part of the book not included in the chapters named, is of the nature of "popular" exposition of various conceptions or quantities concerned in wireless telegraph working: from "ether," discussed in the very first chapter, to "Mutual Induction." This portion of the book evidences clearly that the author is neither a born teacher nor a born writer. The expository logic is poor, and the style is, generally, execrable. An example of both appears on p. 11, where the author attempts to build up the conception of "molecular undulations." He describes the onward motion of water waves, and remarks:

> It is evident, then, that it is not the mass of water that forms the actual onward movement, but that it is the particles of water of which it is composed.

Immediately afterward, stationary waves in a rope are made to illustrate advancing waves.

Again, on p. 49, the author says of alternating currents:

> Ohm's law does not apply to the circuit, but its value largely depends on the frequency with which the reversals take place, and, in circuits containing iron upon the e. m. f. By increasing the frequency of the current the Ohmic resistance decreases in value while the inductance and capacity increases.

And on p. 60 he says:

> Instead of employing the large spheres for the oscillators, it is often more convenient to use circular disks of sheet metal, or square or oblong plates may be used. The formulae for obtaining the specific inductive capacity and its permeability or inductance of these values will be found in the following chapter.

These are by no means isolated examples of the author's style. But fortunately the descriptive chapters that contain the meat of the work are little affected in their clearness by faults of style or logic. The diagrams furnish much of the information with bare reference to the text.

Altogether, a perusal of this book makes one regret the author's ambition in going beyond mere presentation of the arrangements and systems which the inventors in the field have brought forth.

NEW BOOKS

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By W. CHASE THOMSON, M. Can. Soc. C. E.

This book has been developed from lectures given by the author during the past five years, the object of which has been to teach the elements of bridge and structural design in a simple and practical manner. Arts. 1 to 14, inclusive, treat of the general principles of design, and are illustrated by numerous examples; while the remaining Articles are examples of typical structures, in which the stresses are analyzed, the members proportioned, and the details carefully worked out.

Both analytical and graphical methods have been employed for obtaining stresses, and the one which seemed best suited for any particular subject has been adopted. But few tables are given, as it was thought unnecessary to repeat information given in any of the rolling mills' hand-books.

Although the book has been written primarily for students and draughtsmen, it will be found a very useful adjunct to the library of every practicing bridge designer. Particular attention is here drawn to Art. 17, which treats of the design of a knee-braced mill building; and to Art. 29, which discusses the rivet spacing and web splices in plate girders, in which one-eighth of the web plate is counted on as flange area.

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ANNUAL REPORT OF THE COMMISSIONER OF HIGHWAYS, ONTARIO.—1904. A. W. Campbell, Commissioner. Toronto, Ont.: Pub. Doc. Paper; 6½ × 10 ins.; pp. 175; illustrated.

ANNUAL REPORT OF THE PHILIPPINE COMMISSION. —1904. In Three Parts. Bureau of Insular Affairs, War Department. Washington, D. C.: Pub. Doc. Cloth; 6 × 9¼ ins.; pp. 885, 746 and 1,080; folding and other plates.

BOARD OF HEALTH OF THE STATE OF NEW JERSEY.—Twenty-Eighth Annual Report, and Report of the Bureau of Vital Statistics, 1904. Trenton, N. J.: Pub. Doc. Cloth; 6 × 9 ins.; pp. 494; folding and other tables, plates and text figures.

BOOKKEEPING FOR THE PLUMBER.—By George W. Ryan. Pittsburg, Pa.: Standard Sanitary Mfg. Co. Stiff paper; 5 × 7¾ ins.; pp. 60; illustrated.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.

No. 251: The Gold Placers of the Fortymile, Birch Creek, and Fairbanks Regions, Alaska. By Louis M. Prindle. Pp. 89; 16 plates (one in pocket).

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CATALOGUE OF PERIODICAL PUBLICATIONS IN THE LIBRARY OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—New York: The Secretary, 95 Liberty St. Paper; 6 × 9 ins.; pp. 26.

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CEMENTS, LIMES, AND PLASTERS.—Their Materials, Manufacture, and Properties. By Edwin C. Eckel, C. E., Assoc. Am. Soc. C. E., Member Society of Chemical Industry, Assistant Geologist, U. S. Geological Survey. New York: John Wiley & Sons: London: Chapman & Hall, Ltd. Cloth; 6 × 9 ins.; pp. 712; 165 illustrations, mostly in the text, and 254 tables. $6, net.

CLASSIFIED GUIDE TO TECHNICAL AND COMMERCIAL BOOKS.—A Subject-List of the Principal British and American Works in Print. Compiled by Edgar Greenwood. London: Scott, Greenwood & Co. New York: D. Van Nostrand Co. Cloth; 5½ × 8¾ ins.; pp. 216. $3, net.

THE CRYSTALLIZATION OF IRON AND STEEL.—An Introduction to the Study of Metallography. By J. W. Mellor, D. Sc. London, New York and Bombay: Longmans, Green & Co. Cloth; 5 × 8 ins.; pp. 144; 65 figures, partly in the text. $1.00, net.

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LEHRBUCH DER MECHANISCH-METALLURGISCHEN TECHNOLOGIE.—(Verarbeitung der Metalle auf Mechanischem Wege). By A. Ledebur, Professor in the Royal School of Mines at Freiberg, Saxony. Braunschweig, Germany: Friedrich Vieweg & Son. Paper; 6 × 9 ins.; pp. 805; 754 illustrations, mostly in the text. 18 marks; American price, $7.20.

MACHINE-SHOP TOOLS AND METHODS.—By W. S. Leonard, Instructor in Machine-Shop Practice and in Practical Machine Design, Michigan Agricultural College. Third Edition, Revised and Enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 554; 689 figures in the text. $4.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE.—Vol. LXVII., No. 1, 1905. Edited by Bennett H. Brough, Secretary. London: E. & F. N. Spon Ltd. New York: Spon & Chamberlain. Sold also at the offices of the Institute, 28, Victoria St., London, S. W. Cloth; 5½ × 8¾ ins.; pp. 865; text figures, tables and 53 plates.

MAINTENANCE OF COUNTRY ROADS.—By Sam Huston. Bulletin No. 3, Highway Department, State of Ohio. Columbus, O.: Pub. Doc. Paper; 6½ × 9½ ins.; pp. 11.

A PRACTICAL TEST OF THE COPPER SULPHATE METHOD FOR THE REMOVAL OF MICRO-ORGANISMS FROM WATER.—Reprinted from Annual Report of American Public Health Association. By F. S. Hollis, Ph. D., New Haven, Conn. Paper; 6 × 9 ins.; pp. 14.

PROCEEDINGS OF THE ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS.—Toronto, Ont., June 20-21, 1905. (G. P. Conard, Secretary of the Association, 24 Park Place, New York.) Paper; 5¾ × 9 ins.; pp. 222; folding plate.

MODERN REFRIGERATING MACHINERY.—Its Construction, Methods of Working and Industrial Applications. A Guide for Engineers and Owners of Refrigerating Plants. By Prof. Hans Lorenz, Ph. D., Principal of the Institute for Technical Physics, Göttingen University. Authorized Translation from the Third German Edition by Thomas H. Pope, B. Sc., Lecturer in the British School of Malting and Brewing, Birmingham University; with Chapters on American Practice in Refrigeration, Insulation, Auditorium and Other Cooling, by H. M. Haven, S. B., M. Am. Soc. M. E., and F. W. Dean, S. B., M. Am. Soc. M. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 396; tables, and 271 figures in the text. $4, net.

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STRUCTURAL AND FIELD GEOLOGY.—For Students of Pure and Applied Science. By James Geikie, LL. D., D. C. L., F. R. S., Etc., Murchison Professor of Geology and Mineralogy in the University of Edinburgh, Author of "The Great Ice Age," "Prehistoric Europe," "Earth Sculpture," Etc. New York: D Van Nostrand Co. Cloth; 6 × 9 ins.; pp. 455; 56 plates and 142 text illustrations. $4, net.

LIST OF WORKS IN THE NEW YORK PUBLIC LIBRARY RELATING TO BRIDGES AND VIADUCTS. —Bulletin of New York Public Library, August, 1905. Paper; 7 × 10 ins.; pp. 295 to 329. New York: The New York Public Library (I. Ferris Lockwood, Business Superintendent, 40 Lafayette Place). 10 cts. a single number.

This useful list includes references to periodicals as well as to books. The general order of arrangement is by general works, by types, and by localities, the latter alphabetically by countries. Under general works the classes are history, construction, jurisprudence, load, specifications, miscellany.

NEW SOUTH WALES GOVERNMENT RAILWAYS AND TRAMWAYS.—The Railway Commissioners, Sydney, New South Wales. Pub. Doc. Paper; 8½ × 13¾ ins.; pp. 49; with two maps and diagrams.

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